

UNIT 6: TUTORIAL 1: S-BLOCK ELEMENTS GROUP 1 AND 2

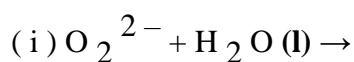
- The alkali metals are low melting. Which of the following alkali metal is expected to melt if the room temperature rises to 30 °C?
(i) Na (ii) K (iii) Rb (iv) Cs (v) Ca
- Alkali metals react with water vigorously to form hydroxides and dihydrogen. Which of the following alkali metals reacts with water least vigorously?
(i) Li (ii) Na (iii) K (iv) Cs (v) Ba
- Some metal carbonates decompose on heating to give metal oxide and carbon dioxide. Which of the metal carbonates is most stable thermally?
(i) MgCO_3 (ii) CaCO_3 (iii) SrCO_3 (iv) BaCO_3 (v) BeCO_3
- Metals form basic hydroxides. Which of the following metal hydroxide is the least basic?
(i) Mg(OH)_2 (ii) Ca(OH)_2 (iii) Sr(OH)_2 (iv) Ba(OH)_2 (v) NaOH
- The order of decreasing 1st 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) $\text{K} < \text{Li} < \text{Na} < \text{Rb}$
- In the synthesis of sodium carbonate, the recovery of ammonia is done by treating NH_4Cl with Ca(OH)_2 . The by-product obtained in this process is
(i) CaCl_2 (ii) NaCl (iii) NaOH (iv) NaHCO_3
- Suspension** of slaked lime in water is known as
(i) lime water (ii) quick lime (iii) milk of lime (iv) aqueous solution of slaked lime (v) limestone
- 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 (v) Sodium bicarbonate
- Several sodium compounds find use in industries. Which of the following compounds are used for textile industry?
(i) Na_2CO_3 (ii) NaHCO_3 (iii) NaOH (iv) NaCl (v) CaCO_3

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

- (i) BeSO_4 (ii) MgSO_4 (iii) BaSO_4 (iv) SrSO_4 (v) RaSO_4

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

12. Complete the following reaction.



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

14. 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.

15. Why are BeSO_4 and MgSO_4 readily soluble in water while CaSO_4 , SrSO_4 are sparingly soluble while BaSO_4 are insoluble?

16. What is the structure of BeCl_2 molecule in gaseous and solid state?

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

Column I

- (i) Cs
- (ii) Na
- (iii) K
- (iv) Ca
- (v) Sr
- (vi) Ba

Column II

- (a) Apple green
- (b) Violet
- (c) Brick red
- (d) Yellow
- (e) Crimson red
- (f) Blue

18. When water is added to compound (A) of calcium, solution of compound (B) is formed. When carbon dioxide is passed into the solution, it turns milky due to the formation of compound (C). If excess of carbon dioxide is passed into the solution milky solution disappears due to the formation of compound (D). Identify the compounds **A**, **B**, **C** and **D**. Explain why the milky solution disappears in the last step.

19. Ions of an element of group 1 participate in the transmission of nerve signals and transport of sugars and amino acids into cells. This element imparts yellow colour to the flame in flame test and forms an oxide and a peroxide with oxygen. Identify the element and write chemical reaction to show the formation of its peroxide. Why does the element impart colour to the flame?

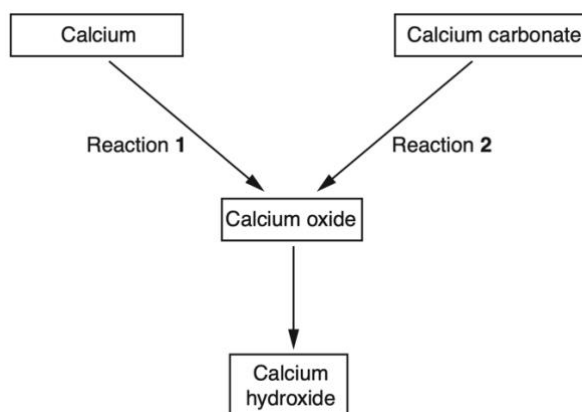
20. This question concerns the chemistry of the Group II metals Mg to Ba. An aqueous solution of the group II metal chloride, XCl_2 , forms a white precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution of XCl_2 does not form a precipitate when dilute aqueous sodium sulphate is added.

An aqueous solution of a different Group II metal chloride, YCl_2 , does not form a precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution YCl_2 forms a white precipitate when dilute aqueous sodium sulphate is added. Suggest identities for the Group II metals X and Y. Write equations, including state symbols, for the reactions which occur.

21.

- (I) State the trend in atomic radius down Group 2 from Mg to Ba and give a reason for this trend.
- (II) State and explain the trend in melting points of the elements down Group 2 from Mg to Ba.
- (III) State the trend in reactivity with water of the elements down Group 2 from Mg to Ba. Write an equation for the reaction of magnesium with steam and an equation for the reaction of strontium with water.
- (IV) Sulfates of the Group 2 elements from Mg to Ba have different solubilities. Give the formula of the least soluble of these sulfates and state one use that depends upon the insolubility of this sulfate.

22. Calcium is in Group 2 of the Periodic Table. The diagram shows some reactions of calcium and its compounds.



- (i) Write the equation for reaction 1.
- (ii) What type of reaction is reaction 2?
- (iii) Calcium hydroxide is both a base and an alkali. Refer to any relevant ions in your answer.
- (iv) A student prepared some calcium hydroxide by adding a small piece of calcium to a large excess of water. Describe what the student would observe and write the equation for the reaction. Observation

(v) A student prepares a solution of calcium nitrate from calcium carbonate. What reagent would the student need to use? Write the equation for the reaction.

23. Hydrated magnesium nitrate, $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, is heated in a boiling tube and the following observations are made.

Stage 1 The white solid forms a clear, colourless solution.

Stage 2 Condensation forms around the mouth of the boiling tube and a white solid starts to form at the bottom of the tube.

Stage 3 As the heating continues, the colourless solution disappears leaving a white solid.

Stage 4 The white solid melts.

Stage 5 A brown gas forms.

Stage 6 A glowing splint reignites when it is placed in the boiling tube.

Stage 7 A white solid is left in the boiling tube.

(a) Explain what is happening in stages 1 and 2.

(b) (i) Identify the products formed in stages 5, 6 and 7.

(ii) Write the equation for the complete thermal decomposition of hydrated magnesium nitrate, $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$.

(c) The chlorides of magnesium and calcium can be distinguished from each other by carrying out a flame test.

(i) Describe what you would see in each test.

Magnesium chloride

Calcium chloride

(ii) Explain how flame colours arise in a flame test.

(iii) Suggest why the observations of the flame tests for magnesium chloride and calcium chloride are different.

24. Metal nitrates decompose on heating. Potassium nitrate, KNO_3 , decomposes to form potassium nitrite and oxygen, whereas calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, decomposes to form calcium oxide, nitrogen dioxide and oxygen.

(a) Write equations for the decomposition of each of these metal nitrates. State symbols are **not** required.

1. Potassium nitrate
2. Calcium nitrate

(b) State **two** things that you would **see** when anhydrous calcium nitrate is heated.

(c) Potassium nitrate and calcium nitrate decompose to form different products. Write balanced chemical equations to explain.

25. How do these characteristic properties change when you go down the s block?

1. Metallic quality 2. Melting point 3. Hardness 4. Density

26. State whether these statements are True or False

- All alkali metals form strong ionic compounds.
- All alkaline earth metals form strong ionic compounds.
- Due to weak ionic character of alkaline earth metal hydroxides, they are less soluble in water than the alkali metal hydroxides.
- What are the reasons for alkali metals to be stored in hydrocarbons?
- What is the easiest test used to identify s block elements ?
- Which elements give red and blue colours from that test respectively ?
- Which of the following elements gives a peroxide when burning in air?
1.Li 2.Na 3.Be 4.Mg 5.Ca
- Which of the following element gives a superoxide when heated in air?
1.Li 2.Na 3.K 4.Sr 5.Ba
- Which one gives an oxide but not a nitride when heated in air?
1.Li 2.Mg 3.Ca 4.Sr 5.Na
- Which one gives both oxide and a nitride ?
1.Li 2.Na 3.K 4.Rb 5.Cs
- Which one does not react when heated with N_2 gas?
1.Mg 2.Ca 3.Sr 4.Na 5.Li
- Which one does not react with cold water ?
1.Sr 2.K 3.Li 4.Ca 5.Mg

27. Write balanced chemical equations for all possible reactions that takes place when a piece Na is exposed to air.

28. Write balanced chemical equations for all possible reactions can happen when a piece of Li is heated in air.

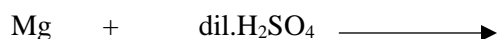
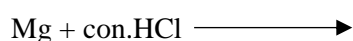
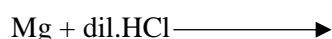
29. Write balanced chemical equations when a piece of Na is reacted with O_2 gas.

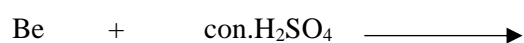
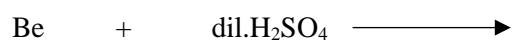
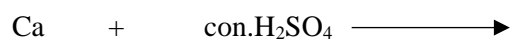
30. The melting point, density, electrical conductivity, thermal conductivity of Mg is higher than those of Na. Explain the reason behind it.

31. Write two reasons for the less reactivity of Mg when compare with Na.

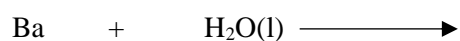
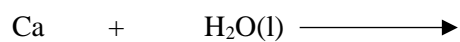
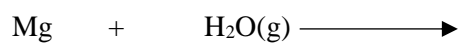
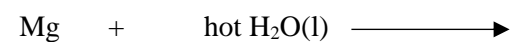
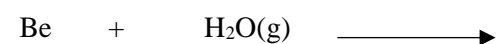
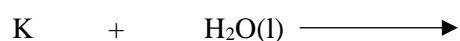
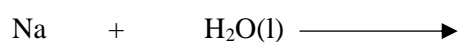
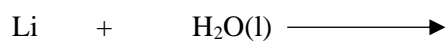
32. Write the reason for the high reactivity of Na when compared with Li.

33. Complete the following reaction by writing balanced chemical equations.





34. Complete the following reactions by writing balanced chemical equations.

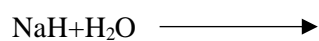
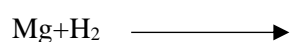
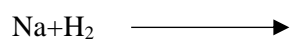
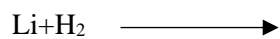


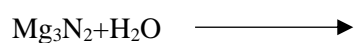
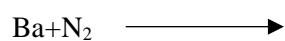
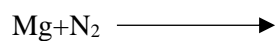
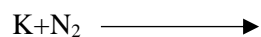
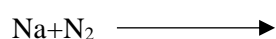
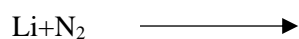
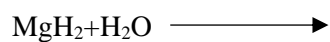
35. Which of the following element release the highest amount of heat by reacting with water ?

1. Na 2.Li 3.K 4.Be 5.Mg

Give the reason for it.

36. Write the balanced chemical equations.





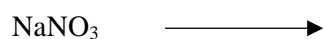
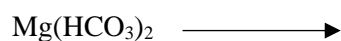
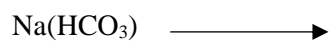
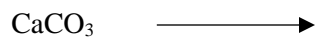
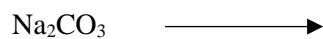
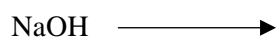
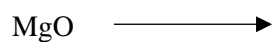
37. After exposing a piece of Na in air for a long time and it was dissolved in water. The product was then added to a dilute solution of HCl.

1. Write the observations.

2. Write balanced chemical equations for all possible reactions taking place.

38. A piece of pure Mg is placed in air and the product is dissolved in dil. HNO_3 and heated until all water is completely removed. Then the resulting residue was heated further. Write all the balanced chemical equations to explain the reactions taking place .

39. Complete the thermal decomposition reactions.



40. Strontium carbonate reacts with nitric acid to produce a solution of strontium nitrate. Strontium sulfate does not react with nitric acid. Describe briefly how you could obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.
41. A metal that gives a red colour in flame test was reacted with N_2 to give a reddish pink colour solid **A**. Upon reaction with water this gave a gas that can make a white smog with a HCl stopper and an aqueous solution of **B** which is basic. If the chloride of this metal has only one ion of the metal identify the metal, **A** and **B**. Write balanced equations for the reactions that has taken place.
42. Write down balanced equations for the reactions of the metal K with O_2 , excess O_2 , H_2 , H_2O .
43. Mg has a higher hardness and a melting point than Na. Explain the reason for this observation referring to its bonding type.
44. Solubility of the halides of Na increases down the group of halides. Explain this statement using the following thermochemical data and suitable calculations.

Salt	$\Delta H_f^\circ / \text{kJ mol}^{-1}$	$\Delta S_f^\circ / \text{J mol}^{-1}\text{K}^{-1}$
NaF	+1	+3
NaCl	+4	-9
NaBr	-1	-19
NaI	-9	-32

45. A certain aqueous solution contains two cations of which belongs to **s block**. Following tests were carried out to identify them. H_2SO_4 was added to the solution and a white precipitate was formed. The flame test was carried out to the remaining solution after filtering the solution. A bright yellow colour appeared. Flame test on the precipitate formed gave a yellowish green (apple green colour). Identify these two cations and answer these questions.
- Write down balanced equations for the thermal decompositions of their carbonates and nitrates.
 - Out of the two hydroxides of the two cations, which is more basic? Explain your answer.
 - Select the cation which has a higher atomic radius and write equations to explain the reactions of it with conc H_2SO_4 and conc. HNO_3 .
46. Explain the extraction process for Mg from sea water. How would you suggest extract Ca using limestone following a similar process. Please make references to balanced chemical equations at each step when answering the question.
47. Write balanced chemical equations to explain the thermal decomposition of $LiNO_3$, $NaNO_3$, KNO_3 . Which compound gives a reddish-brown gas upon heating? Draw the structure of this gaseous species. KNO_3 is used to manufacture various pyro techniques. Explain why. Suggest two other potassium salts that could be used for this process. Write balanced chemical equations to explain the use of these two salts for the purpose of fireworks.

48. Magnesium can be heated in the atmosphere to form a white powder which is a mixture of two products. Adding water to this mixture forms a white precipitate and a gas that can make Nessler's reagent turn yellow to brown colour. Write balanced chemical equations for the reactions that occur. You don't need to write what happens in the Nessler's reagent.
49. White precipitate described in question 33 was heated with HCl(g) to form a crystalline product. Once this product was heated to melt it was electrolyzed using graphite electrodes. Write down equations for the reactions taking place. Resulting metal is stored by applying a protective coating on the surface. What is the purpose of this technique?
50. Compounds **A(aq)** and **B(aq)** react to form a precipitate **C** and aqueous solution **D**. Following tests were carried out to identify the compounds **A**, **B**, **C** and **D**. **A** was heated to give a reddish-brown gas and another gas that can reignite a burning flint. **B** gave a Lilac colour in the flame test. All experiments on **C** concluded that it is limestone. Write down balanced equations to explain all observations and the main reaction.
51. **P** and **Q** salts contain metal ions derived from s-block elements that are soluble in water to form aqueous solutions. Mixing of these two solutions gave a precipitate **R** which is also a sulphate insoluble in acids and **S** which is a strong base. There is no evolution of gases. **Q** gives a characteristic yellow colour to the Bunsen flame and **P** is a highly soluble hydroxide. Its' metal to O ratio is 1:2. Identify **P**, **Q**, **R** and **S**. Write the balanced chemical equation with the physical states to explain the main reaction.
52. There are many uses for compounds of barium. Write an equation for the reaction of barium with water. State the trend in reactivity with water of the Group 2 metals from Mg to Ba. Give the formula of the **least** soluble hydroxide of the Group 2 metals from Mg to Ba. State how barium sulfate is used in medicine. Explain why this use is possible, given that solutions containing barium ions are poisonous.
53. Explain why the first ionisation energy of barium is less than the first ionisation energy of calcium. Magnesium reacts readily with steam. State **two** observations you would make when magnesium reacts with steam. Write an equation for the reaction. Explain why different observations are made when aqueous barium chloride is added separately to aqueous magnesium sulfate and to aqueous magnesium nitrate. Write the simplest ionic equation, including state symbols, for any reaction that occurs.
54. Solutions of barium hydroxide are used in the titration of weak acids. State why magnesium hydroxide solution could **not** be used for this purpose. Magnesium metal is used to make titanium from titanium(IV) chloride. Write an equation for this reaction of magnesium with titanium(IV) chloride. Magnesium burns with a bright white light and is used in flares and fireworks. Use your knowledge of the reactions of Group 2 metals with water to explain why water should **not** be used to put out a fire in which magnesium metal is burning.

55. Li, Na, K, Rb, Cs and Fr are stored immersed in hydrocarbons. Briefly explain the reasons for this. 5.

56. a) Write the balanced chemical equations for the reactions taking place when the following metals are burned in air.

- i. Na
- ii. K

b) Give the oxidation state of O in each of the products formed in (a) above.

57. How would you qualitatively determine the presence of N_2 in atmospheric air? Explain using relevant balanced chemical equations and observations.

58. Write balanced chemical equations (if any) for the reaction of the following species with water.

- a) Li metal with cold water
- b) Na metal with cold water
- c) Be with cold water
- d) Mg with cold water
- e) Mg with boiling water
- f) Mg with water vapour
- g) Ca with cold water
- h) Sr with hot water

59. Write balanced chemical equations for the reaction of Mg metal with the following acids.

- a) With dilute HCl
- b) With dilute H_2SO_4
- c) With dilute HNO_3
- d) With conc. HCl
- e) With 50% dilute H_2SO_4
- f) With conc. H_2SO_4