CHAPTER

8 Some Important Man made Materials

Chemistry has helped significantly in meeting human needs by providing chemical fertilizers, improved varieties of insecticides and pesticides to increase the yield of crops and fruits. It has given us a large number of life saving drugs. Also chemical industries manufacturing polymers, soaps, detergents, glass, ceramics etc.

Industrially Important Compounds

1. Glass

It consists of a mixture of two or more silicates.

Preparation of glass :

Common glass (or soft glass) : It is used to make bottles, glass wares etc. and is obtained by heating together silica (in the form of sand), sodium carbonate or sodium sulphate and chalk or lime stone (calcium carbonate). Some broken glass and a little coke are usually added. The glass so prepared consists of silicates of sodium and calcium.

$Na_2CO_3(s) + SiO_2(s) \rightarrow Na_2SiO_3(s) + CO_2(g)$
(silica)

$Na_2SO_4(s) + SiO_2(s) \rightarrow Na_2SiO_3(s) + SO_3(g)$

$CaCO_3(s) + SiO_2(s) \rightarrow CaSiO_3(s) + CO_2(g)$

Hard glass : For preparation of hard glass K_2CO_3 is used in place of Na_2CO_3. It consists of a mixture of calcium and potassium silicates.

Physical properties of glass : Hard, rigid, high viscosity, bad conductor of heat and electricity, brittle, etc.

Blowing : It is a method to cast the molten glass into different moulds. There are two different methods of glass blowing

(i) Free blowing and (ii) Mould blowing

Free blowing : It involves the blowing of air to inflate the molten glass which is gathered at one end of the blow pipe to give the desired shape.

Mould blowing : This method was developed after the technique of free blowing. In this method, molten glass is inflated into a wooden or metal carved mould with the help of blow pipe which gives the molten glass the shape and design of the interior of the mould.

Chemical properties of glass

(1) It is resistant to action of air and acids except hydroflouric acid.

(2) It is alkaline in nature.

(3) It slowly reacts with water to form alkaline solution.

Types of Glass

(i) Silica glass : For this type of glass the raw material used is 100% pure form of *quartz.* It is quite *expensive*. It is used in the manufacture of laboratory apparatus. It has low thermal expansion. Its softening point is very high and it is resistant to a wide variety of chemicals.

(ii) Alkali silicate glass : For it the raw materials used are sand and soda. It is also called **water glass** because it is soluble in water and used only as a solution. It is generally used to make gums and adhesives.

(iii) Lead glass : For this type of glass lead oxide is added to ordinary glass. The addition of lead oxide increases the density and also the refractive index. This type of glass is used for the manufacture of ornamental glass ware, decorative articles etc.

(iv) Optical glass : This type of glass is used in the manufacture of optical instruments like binoculars, spectacles, lenses, prisons, telescopes, microscopes etc. It is transparent and can be grounded into the required shape. It generally contains phosphorus, and lead silicates with little cerium oxide which absorbs UV radiations.

(v) Processed glass : The properties and applications of glass also depend upon the processing of glass.

Some types of processed glass and their applications are given here :

Processed glass		Applications
1.	Laminated glass	Used for doors and windows of automobiles. (It has high strength).
2.	Fibre glass	Used for reinforcing purpose (It has enough tensile strength)
3.	Foam glass	Used for civil construction and insulation purposes (it is light weight).
4.	Opaque glass	In it non-transparent glass filters the light entering into it. Thus provides an aesthetic look.

(vi) Borosilicate glass : It contains silica and Boron oxide and small amount of oxides of sodium and aluminium. It is resistant to a wide variety of chemicals due to this property it is used in the manufacture of laboratory ware.

2. Fertilizers

Fertilizers are chemical compounds which when added to the soil increase their fertility and directly supply the need of essential elements [N, P, K] of primary importance.

Classification : Chemical fertilizers are broadly classified into the following three types :

(i) **Nitrogenous fertilizers :** Ammonium sulphate, urea etc.

(ii) **Phosphatic fertilizers :** Super phosphate, ammonium phosphate

(iii) **Potash fertilizers :** Potassium chloride, potassium sulphate.

3. Soaps and detergents

Soap : Fatty acid salts of sodium and potassium are known as soaps. These are prepared by the action of fatty acids with sodium hydroxide or potassium hydroxide.

Fatty acid + sodium hydroxide $\rightarrow$ Soap + glycerol.

Detergents are sodium salt of long chain sulphonic acids or alkyl hydrogen sulphate.

Advantages of detergents over soaps

(i) Detergents can be used for laundering even with hard water as they are soluble even in hard water.

(ii) Detergents possess better cleansing properties than soaps.

Disadvantages of detergents over soap : Detergents are prepared from hydrocarbons, while soaps are prepared from edible fatty oils. Thus they are non biodegradable.

Saponification : It is the process of making of soap by the hydrolysis of fats and oils with alkalis.

Both soaps and detergents are soluble in water and act as **surfactants** which reduce the surface tension of water to a great extent. This increases the water - fabric interaction as a consequence of which dirt particles, grease spots etc are washed away effectively. In other words soaps and detergents enhance the cleansing action of water.

4. Portland cement : It was first discovered in England. It is essentially a mixture of lime stone and clay. It was called Portland cement because in presence of water it sets to a hard stone-like mass resembling with the famous Portland rock. The approximate composition of Portland cement is

Calcium oxide (CaO)	62%
Silica (SiO_2)	22%
Alumina (Al_2O_3)	7.5%
Magnesia (MgO)	2.5%
Ferric oxide (Fe_2O_3)	2.5%

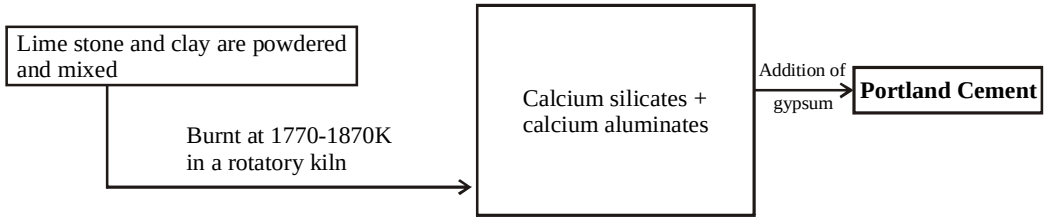
The above compounds are provided by the two raw materials, namely lime stone (which provides CaO) and clay (which provides SiO_2, Al_2O_3 and Fe_2O_3). In cement, almost entire amount of lime in present in the combined state as calcium silicate ($2CaO.SiO_2$ and $3CaO.SiO_2$) and calcium aluminates ($3CaO.Al_2O_3$ and $4CaO.Al_2O_3$).

(i) Cement containing excess amount of lime cracks during setting; while cement containing less amount of lime is weak in strength.

(ii) Cement with excess of silica is slow-setting and that having an excess of alumina is quick-setting.

(iii) Cement containing no iron is white but hard to burn.

Cement is manufactured by two processes, viz. wet and dry. A small amount (2–3%) of gypsum is added to slow down the setting of the cement so that it gets sufficiently hardened. Setting of cement is an exothermic process and involves hydration of calcium aluminates and calcium silicates.



Important Biomolecules

Vitamins

Vitamin generic descriptor name	Solublility	Deficiency disease	Overdose disease
Vitamin A	Fat	Nightblindness and Keratomalacia	Hypervitaminosis
Vitamin B_1	Water	Beriberi, Wernicke-Korsakoff syndrome	Drowsiness of music relaxation with large doses
Vitamin B_2	Water	Ariboflavinosis	
Vitamin B_3	Water	Pellagra	Liver damage (doses > 2g/day) and other problems
Vitamin B_5	Water	Paresthesia	Diarrohea; possibly nausea and heartburn
Vitamin B_6	Water	Anemia peripheral neuropathy nerve damage (dose > 100 mg/day)	Impairment of proprioception
Vitamin B_7	Water	Dematitis, enteritis	
Vitamin B_9	Water	Deficiency during pregnancy is deficiency, other effects	May mask symptoms of vitamine$_{12}$ associated with birth defects, such as neural tube defects
Vitamin B_{12}	Water	Megaloblastic anemia	No known toxicity
Vitamin C	Water	Scurvy	Vitamin C megadosage
Vitamin D	Fat	Rickets and Osteomalancia	Hypervitamin osis D
Vitamin E	Fat	Deficiency is very rare; mild hemolytic anemia in newborn	Increased congestive heart failure seen in one large
Vitamin K	Fat	Bleeding diathesis	Increases coagulation in patients taking warfarin.

EXERCISE

1. Deficiency of vitamin A results in
   (a) lose in apetite (b) skin diseases
   (c) sterility (d) retarted growth
2. Which one of the following contains cobalt ?
   (a) Riboflavin (b) Vitamin B_{12}
   (c) Vitamin A (d) Vitamin B_6
3. Night-blindness is caused due to the deficiency of
   (a) Vitamin D (b) Vitamin A
   (c) Vitamin C (d) Vitamin B
4. Alkaline hydrolysis of esters is known as
   (a) esterification (b) saponification
   (c) dehydration (d) alkalination
5. Deficiency of vitamin E causes
   (a) Beriberi (b) Scurvy
   (c) Hemolytic anemia (d) None of these
6. Scurvy is caused due to the deficiency of vitamin
   (a) B_1 (b) C
   (c) K (d) A
7. Which of the following statements, is not correct, about glass?
   (a) Because of its high viscosity glass exists in solid state
   (b) There is no definite melting point for glass.
   (c) The silicate units in glass are arranged in a way that is quite similar to the arrangement found in liquids.
   (d) Glass is a solid because it has a regular crystalline arrangement.
8. The property of plasticity is shown by clay , when it is
   (a) mixed with proper proportion of water
   (b) heated strongly
   (c) dried at room temperature after kneading
   (d) glazed
9. One of the properties of glass is its transparency. This property of glass is due to
   (a) its high viscosity.
   (b) regular arrangement of silicate units in glass.
   (c) irregular arrangement of silicate units in glass.
   (d) its high coefficient of thermal expansion.

10. Washing soaps are potassium and sodium salts of
(a) dicarboxylic acids (b) fatty acids
(c) mineral acids (d) None of these

11. When glass is heated, it
(a) does not melt at a fixed temperature
(b) vapourises
(c) melts only above 1000°C
(d) None of these

12. Glass is a transparent substance obtained by heating silica with oxides or carbonates of metals. Glass is a mixture of
(a) phosphates (b) sulphates
(c) oxides (d) silicates

13. Potash (Potassium carbonate) is used as a fertilizer. It is also known as
(a) azo compound (b) oil of vitriol
(c) pearl ash (d) Glauber's salt

14. Soft soaps are
(a) sodium and potassium salt
(b) sodium salt of fatty acids
(c) potassium salt of fatty acids
(d) potassium salt of sulphonic acids

15. Soaps are
(a) sodium salts of sulphuric acids containing carbon atoms 10 to 16
(b) sodium salts of fatty acids containing carbon atoms 16 to 18
(c) sodium salts of trihydroxy alcohols
(d) none of these

16. Soaps are sodium salts of fatty acids. Which of the following fatty acid does not form soap?
(a) Butyric acid (b) Oleic acid
(c) Palmitic acid (d) Stearic acid

17. Which one of the following is not contained in portland cement ?
(a) $Ca_3Al_2O_6$ (b) Ca_3SiO_5
(c) Ca_2SiO_4 (d) $Ca_3(PO_4)_2$

18. What is the reason for white cement to be white?
(a) It does not contain carbon
(b) It does not contain silicon
(c) It does not contain iron
(d) It does not contain calcium

19. Which one of the following is **not** present in cement?
(a) Clay (b) Alumina
(c) Alum (d) Gypsum

20. Which substance is used to retard the setting action of cement?
(a) CaO (b) Al_2O_3
(c) $CaSO_4, 2H_2O$ (d) $Na_2O + K_2O$

21. Which of the statements about glass are correct?
1. Glass is a super-cooled liquid having infinite viscosity.
2. Violet coloured glass is obtained by adding MnO_2.
3. Glass is a man-made silicate.
4. Glass is a crystalline substance.
Select the correct answer using the codes given below.
(a) 1, 2 and 4 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) 1 and 3

22. Which one among the following is the main ingredient in cement?
(a) Gypsum (b) Limestone
(c) Clay (d) Ash

23. Glass is actually
(a) a crystalline solid (b) an ionic solid
(c) an elastic solid (d) a vitrified liquid

24. The major component used in preparation of different types of glasses is
(a) silica (b) sodium borate
(c) calcium silicate (d) sodium silicate

25. The reaction that takes place in soap making is called saponification. Basically soap is sodium or potassium salts of
(a) long chain monocarboxylic acids
(b) glycerol
(c) long chain dicarboxylic acids
(d) long chain tricarboxylic acids

26. The most important raw materials used in the manufacture of cement are
(a) potassium nitrate, charcoal and sulphur
(b) limestone, clay and gypsum
(c) transition metal oxides, sodium hydroxide or potassium hydroxide
(d) limestone, sodium carbonate and silica

27. Given below is an approximate composition of a substance :

CaO	60-70%
SiO_2	20-25%
Al_2O_3	5-10%
Fe_2O_3	2-3%

The substance is
(a) plaster of Paris (b) cement
(c) marble stone (d) quartz

28. The principle of cleaning by soap is
(a) surface tension (b) floatation
(c) viscosity (d) elasticity

29. By which one among the following mechanisms, soap removes dirt (soil) from cloth?
(a) Soap dissolves the soil as such
(b) Soap reacts with soil and converts them into soluble silicates
(c) Soap takes away the oily part of the soil and thus separates the soil from the cloth
(d) The soap molecules bind with the soil, lift the soil and keep it suspended which can then be rinsed away

30. Consider the following statements
1. Soap cannot be used in acidic water.
2 Ionic part of a soap is $—COO^- \cdot Na^+$.
3. Soap dissolves in water faster then detergent.
Which of the statements given above is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 3 only (d) 1 only

31. What is the composition of nitrolim – a chemical fertilizer ?
(a) Nitrogen and limestone
(b) Calcium carbide and nitrogen
(c) Calcium carbide and carbon
(d) None of these

32. Which one of the following correctly defines the state of glass?
(a) Crystalline solid (b) Super cooled liquid
(c) Condensed gas (d) Liquid crystal

33. Flint glass is obtained from which of the following ?
(a) Zinc and barium borosilicate
(b) Sand, red lead and potassium carbonate
(c) Sodium aluminum borosilicate
(d) Pure silica and zinc oxide

34. Which of the following statements about vitamin B_{12} is incorrect ?
(a) It has a cobalt atom
(b) It occurs in plants
(c) It is also present in rain water
(d) It is needed for human body in very small amounts

35. Washing soap can be prepared by saponification with alkali of which of the following oil
(a) Rose oil (b) Paraffin oil
(c) Groundnut oil (d) Kerosene oil

36. The aqueous solution of one of the following vitamins is dark in colour
(a) B_1 (b) B_2
(c) B_6 (d) B_{12}

37. Which one of the following is a vitamin?
(a) Benzoic acid (b) Ascorbic acid
(c) Oxalic acid (d) Formic acid

ANSWER KEY													
1	(d)	**7**	(d)	**13**	(c)	**19**	(c)	**25**	(d)	**31**	(d)	**37**	(b)
2	(b)	**8**	(a)	**14**	(c)	**20**	(c)	**26**	(b)	**32**	(b)		
3	(b)	**9**	(c)	**15**	(b)	**21**	(d)	**27**	(b)	**33**	(b)		
4	(b)	**10**	(b)	**16**	(a)	**22**	(b)	**28**	(a)	**34**	(c)		
5	(c)	**11**	(a)	**17**	(d)	**23**	(c)	**29**	(d)	**35**	(c)		
6	(b)	**12**	(d)	**18**	(c)	**24**	(a)	**30**	(a)	**36**	(d)		

HINTS AND SOLUTIONS

1. (d) In childhood, lack of vitamin A retards growth and hence like other vitamins, it is also said to be a growth promoting factor. In mild deficiency it leads to night blindness. Its prolonged deficiency leads to xerophthalmia.

2. (b) Vitamin B_{12} (Cyanocobalamines) : Cobalamine has by far the most complicated structure of all the vitamins. It has cobalt atom in the centre. It also has – CN groups in its structure. It is a pink coloured crystalline, water soluble vitamin.

3. (b) Night-blindness is caused due to the deficiency of vitamin A.

4. (b) Alkaline hydrolysis of esters is known as saponification.

$$R - COOR' + NaOH \longrightarrow R'OH + RCOONa$$

6. (b) Scurvy (bleeding of gums) is caused due to deficiency of vitamin 'C' (ascorbic acid).

17. (d) A typical composition for portland cement is CaO, SiO_2, Al_2O_3, Fe_2O_3, $CaSO_4.2H_2O$.
$\therefore$ $Ca_3(PO_4)_2$ is not contained in portland cement.

18. (c) White cement is white since it does not contain iron.

19. (c) Gypsum is added in calculated quantity in order to adjust the rate of setting of cement. Alum is NOT present in cement.

20. (c) $CaSO_4.2H_2O$ (**gypsum**) is added to cement **clinker** to retard setting action of cement.

21. (d) Glass is an amorphous substance.

22. (b) The composition of cement is CaO (lime) or limestone 62%, silica (SiO_2) 22%, alumina (Al_2O_3) 7.5%, magnesia (MgO) 2.5%, etc. Thus, limestone is the major raw material for cement.

23. (c) Glass is actually an elastic solid. H_2O and aqueous NaOH can be differentiated with the help of red litmus.

24. (a) The major component used in the preparation of different types of glasses is silica.

25. (d) Vegetable oils and animal fats are the main materials that are saponified. These greasy materials, triesters called triglycerides, are mixture derived from diverse long chain tricarboxylic acid.

26. (b) Cement is manufactured with limestone, clay and gypsum.

27. (b) Cement is made up of calcium oxide, silicon dioxide, aluminium tetra oxide and iron tetra oxide.

28. (a) Soaps form surface films, reduce surface tension of solution and help in removing dirt and dust by emulsifying grease.

29. (d) The soap molecules form micelle around the dirt particles prevents them from coming together and form aggregates, which form emulsion in water. The hand rubbing or the agitation cause dispersion of the dirt particles throughout the soapy water. These are washed away with water along with dust particles. In this way dirt are removed from the surface of the cloth.

30. (a) Detergent dissolves in water faster than soap.

31. (d) Calcium cyanamide ($CaCN_2$) mixed with carbon (C) is called **nitrolim.**

$$\underset{\text{Cal.Carbide}}{CaC_2} + N_2 \longrightarrow \underbrace{CaCN_2 + C}_{\text{Nitrolim}}$$

32. (b) Glass is an amorphous, hard, brittle, super cooled liquid.

33. (b) Flint glass is obtained from red lead and potatassium carbonate.

34. (c) It is found in liver, egg, milk, meat, and fish. Minute amounts are probably present in all animal cells. Peculiarly, unlike other vitamins, B_{12} is not found in significant amounts in green plants.

35. (c) Any oils which are good for eating or cooking, can be used in making soap. One of the best is said to be Coconut oil. Groundnut, shea butter, cocoa butter, sun flower and many other vegetable oils are also used.

36. (d) The aqueous solution of vitamin B_{12} is dark in colour.

37. (b) Vitamin C is chemically ascorbic acid.