UNIT – IV
ENGINEERING MATERIALS
PART A

1. **What are abrasives? Give two examples each for Natural and Artificial abrasives.**
   Abrasives are hard substances, used for polishing, shaping, grinding operations. They are characterized by high melting point, high hardness and chemically inactive.
   Example: Natural abrasives – Diamond, Emery
   Synthetic abrasives – Silicon carbide, Boron carbide
2. **What is Corundum?**
   Corundum is crystalline aluminum oxide(Al_2O_3).Its hardness is 9 in Moh‘s scale. It is used in grinding wheels and glasses.
3. **What are refractories?**
   Materials that can withstand high temperature without Softening or undergoing any deformation in shape are called refractories. Example: Silicon carbide, Zirconia
4. **Mention any three characteristics of good refractories.**
   (i) It should be infusible at high operating temperatures.
   (ii) It should be chemically inert towards corrosive action of gases, metallic slags and liquids produced in the furnaces.
   (iii) It should resist the abrading action of flue gases, flames etc.
   (iv) It should have high refractoriness
5. **What is meant by refractoriness of a refractory?**
   It is the temperature withstanding capacity of a material. It refers the ability of a material to withstand very high temperature without softening or deformation under particular service conditions.
6. **What is meant by pyrometric cone equivalent of a refractory?**
   It is the number which indicates the softening temperature of a particular refractory specimen with standard dimensions(38mm height, and 19mm triangular base) and composition. Silica bricks -PCE number 32, Alumina bricks - PCE number 37
7. **What is thermal spalling? How is it minimized?**
   It is the property of breaking or cracking or peeling off a refractory material under high temperature, especially when there is a sudden change in temperature. Thermal spalling is due to rapid change in temperature and also due to slag penetration.
   It can be minimized by two ways.
   i) By avoiding sudden changes in temperature.
   ii) By using high porosity, low coefficient of expansion and good thermal conductivity refractory.
8. **What are the raw materials used for the manufacture of cement.**
   (i). Calcareous materials, CaO (limestone)
   (ii). Argillaceous materials, Al_2O_3 and SiO_2 (clay)
   (iii). Powdered coal or fuel oil
   (iv). Gypsum ($CaSO_4$. $2H_2O$)
9. **Define the glass?**
   Glass is an amorphous, hard, brittle and transparent or translucent, super-cooled liquid, obtained by fusing a mixture of a number of metallic silicates. Most commonly silicates of Na, Ca and Pb are used. It possesses no sharp melting-point, crystalline structure and definite formal.
10. **What are the important uses of Glass wool?**
    (i). It is used for electrical and sound insulation.
    (ii). It is used in filtration of corrosive liquids like acids.
    (iii). It is also used for manufacturing fibre-glass, by blending with plastic resins.

PART B

1. What are soft abrasives? Give examples. Describe the classification of abrasives with suitableexamples. Explain Moh's scale of hardness.

Hardness:

It is the ability of an abrasive to grind or scratch away other materials. The harder the abrasive quicker will be its abrading action. Hardness of the abrasive is measured on Moh's scale or Vicker's scale.

Moh's scale is a scale, in which common abrasive (natural or artificial) are arranged in the order of their increasing hardness.

Soft abrasives:

Abrasives having their hardness 1-4 in Moh's scale are known as soft abrasives.

Example: Talc, Gypsum, Calcite, Fluorite

Classification of abrasives:

Abrasives are classified into two types.

1. Natural abrasives

a) Non – siliceous abrasives:

Examples: Diamond, Corundum, Emery

b) Siliceous abrasives:

Examples: Quartz, Garnets

2. Artificial abrasives:

Examples: Carborundum, Norbide, Alundum

2. Write a note on synthetic abrasives.

Synthetic abrasives

1. *Carborundum or Silicon carbide*

Manufacture:

Silicon carbide is manufactured by heating sand(60%) and coke(40%) with some sawdust and a little salt in an electric furnance at about 1500^0C.

Saw dust increases the porosity.

Salt reacts with iron and other similar impurities, present in the raw materials, forming volatile chlorides. This also increases the porosity.

$SiO_2 + 3C \rightarrow SiC + 2C$

The silicon carbide, removed from the furnance, is then mixed with bonding agent (Clay) and then shaped, dried and fired.

Properties:

- Its Moh's scale value is 9.
- It can withstand up to 1650^0 C.
- It is hard and brittle.
- It has thermal conductivity between metals and ceramics.
- It high mechanical strength.

Uses:

a. Silicon carbides are used as heating elements in furnaces in the form of rods and bars.
b. They are used in kilns, coke ovens, muffle furnaces and floors of heat treatment furnaces.
c. SiC bonded with tar is used for making high conductivity crucibles.

2. Nor boride or boron carbide (B_4C)

Manufacture:

It is prepared by heating a mixture of boron oxide and coke in an electric furnance at about 2700^0C.

Properties:

- ✓ Its hardness is 10 in Moh's scale.

- ✓ It is light weight and black coloured compound.
- ✓ It is highly resist to chemical attack and erosion.
- ✓ It resists oxidation much better than diamond.

Uses:

It is used for cutting and sharpening hard high speed tools.

It is used to prepare scratch and resistant coatings.

3.Alundum (Al_2O_3)

Manufacture: It is prepared by heating a mixture of calcined bauxite, coke and iron in an electric furnace to about 4000 °C

$$\text{Bauxite}+3O_2 \rightarrow 2Al_2O_3$$

Properties

1. It is an artificial corundum and is not as hard as carborundum but is less brittle and tougher.
2. It is stable at high temperature.
3. Its hardness is 9 in moh's scale.
4. It is resistant to acids.

Uses

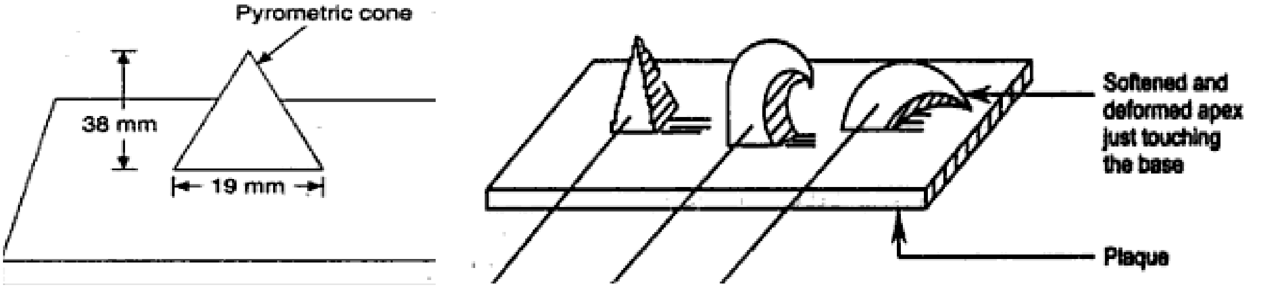
1. It is used in grinding of hard steels and other materials of high tensile strengths.
2. It is also used in the manufacture of abrasives wheels.

3. a. Discuss in detail about any three properties of refractories.
b.Classify refractories and give one example for each type.

Refractoriness:

1. The ability to withstand very high temperature without undergoing any deformation in shape is called refractoriness.
2. It is necessary that a material , to be used as refractory, should have a softening temperature much higher than the operational temperature of the furnace.
3. It is determined by Pyrometric Cone Equivalent (PCE) test.
4. Pyrometric or Seger cones are made up of definite composition and definite dimension. (19 mm base and 38mm height- pyramid shaped).
5. A series of Seger cones are placed in an electric furnace along with our specimen with the same dimension. The electric plate is heated through 10°C increment. The temperature at which the apex of the specimen touches the bottom of the table is called refractory temperature. The corresponding Seger cone number is taken as PCE value. Greater the PCE value, greater will be the refractory temperature. PCE values ranges from 1 to 40.
6. Seger number 1 corresponds to 1110 °C , 2 corresponds to 1120 °C and so on.

No	Name	PCE value	Temperature
1	Silica	32	1710°C
2	Alumina	36	1800 °C
3	Magnesite	38	1850 °C



cone38 , cone37 , cone 36

7. *Objectives of PCE test:*

a) Determination of the softening temperature of a refractory material.
b) Classification and testing the purity of refractories.
c) Checking whether a given refractory material can be used at the particular servicing temperature.

Refractoriness under load (RUL):
1. It is essential that refractory materials must also possess high mechanical strengths, even at operating temperatures, to bear the maximum possible load, without breaking.
2. The ability to withstand very high temperature without any deformation under high pressure and load is called RUL. It is determined by RUL test.
3. Our test specimen is made up into dimensions of 5 cm^2 base and 75cm height.A constant pressure of 1.75 Kg / cm^2 is applied on the specimen and the temperature is raised through 10^oC .
4. The record of the height of the specimen versus temperature is made by a plot.
5. The temperature at which 10% deformation occurs is known as RUL temperature. RUL temperature is always less than refractoriness

Porosity:

Porosity is the ratio between pore volume to the bulk volume.

$$P = \frac{\text{Pore volume}}{\text{Bulk volume}}$$

$$P\ \% = \frac{W - D}{W - A} \times 100$$

Where, W = Weight of saturated specimen
D = Weight of dry specimen
A = Weight of specimen when submerged in water

Depending on the applications, the refractories may have high porosity or low porosity.

Disadvantages of high porosity:
1. It reduces the strength,
2. It causes corrosion,
3. It causes abrasion.

Advantages of high porosity:
1. The air in the pores act as an insulator. So, it reduces the heat loss.
2. Due to high porosity, expansion and shrinkage is maintained in equilibrium. So, it reduces thermal spalling.

Classification of refractories:

A) Based on Chemical Composition

TYPE & EXAMPLE	RAW MATERIAL	BINDER	FIRING TEMP	PROPERTIES	USES
Acidic i) Alumina ii) silica	Al_2O_3	Clay	1700^oC	1.Affected by bases 2. Not affected by H_20, CO_2 3. porosity is 8.3% 4.Low coefficient of expansion 5. great resistance to slags 6. low spalling 7.Refractriness 1500 ^oC 8. RUL 1350 ^oC	1.Cement industries 2.Aluminium industries 3. Brass production 4. Lead kilns

Basic i)Magnesiteii) Dolomite	Calcined MgO	Fe_2O_3	1500^oC	1.Affected by acids 2.25% porosity 3. Undergoes spalling 4. Refractoriness 2000^oC 5. RUL 1500^oC 6. Poor abrasion resistance 7. Very little shrinkage	1. Steel industries 2.Copper industries 3.Bessemer Converter 4.Antimony convertors 5.Refining furnaces of gold, silver and platinum
Neutral i)Zirconia ii)Graphite	ZrO_2	Colloidal zirconia + MgO stabilizer	1770^oC	1.Low thermal expansion 2.Affected by H_20, CO_2 3.Undergoes very low spalling 4. Refractoriness 2000^oC 5. RUL 1900^oC 6. Costly 7.Resistant to thermal shocks	1. High voltage electric furnaces.

B) Based on Thermal property

No	TYPE	PCE value	Refractoriness Temp (^oC)	Examples
1	Low heat duty refractories	19 - 28	1520 – 1630	Impure silica
2	Intermediate heat duty ref.	28 – 30	1630 – 1670	Fireclay
3	High heat duty refractories	30 – 33	1670 – 1730	Chromite
4	Super heat duty refractories	Above 33	Above 1730	Magnesite

4. Explain the manufacture, properties and uses of alumina and magnesite bricks.

1. Aluminous refractories:

It contains higher percentage of mineral Kaolinite($Al_2O_3.SiO_2.2H_2O$).

Grinding:

The raw materials **clay** (mixture of silica and alumina) and **grog** (calcined, granulated fireclay are ground to small size in a **pug mill.**

Mixing:

Then the powdered raw materials are mixed with water (Binding material)

Moulding:

Moulding can be done by machine pressing, tamping, slip casting.

Burning:

Burning can be done using kilns. Various types of kilns are used like continuous kilns, tunnel kilns.
Time required is 6-10 days
Temperature 1200-1400^0 C
Cooling process takes time of 7- 10 days according to the kilns used.
Care should be taken to avoid cracking of the refractory.

Properties:

1. RUL is 1350^{0}C under the load of 3.5 Kg/cm^2
2. Porosity is 8.3%
3. Spalling tendency can be minimized by using calcined fireclay (grog).

Uses:

Fireclay bricks are used in lime kils, glass furnances and steel industries.

2. Magnesite bricks:

Grinding:

The raw material **magnesite** is calcined at about 1600^0 C and then crushed to fine powder in crushers.

Mixing:
Then the powdered raw materials are mixed with iron oxide (Binding material)
Moulding:
Moulding can be done by hydraulic pressers.
Drying:
It should be done very slowly and carefully.
Burning:
Burning can be done using kilns.
Temperature is 1500^0 C and the time required is 4 weeks.
Properties:
1. RUL is 1500^0C under the load of 3.5 Kg/cm^2
2. Porosity is 25%

Uses:
1. It is used in the furnaces of gold, silver, platinum, steel industries.
2. It is used in the lining the basic converters.

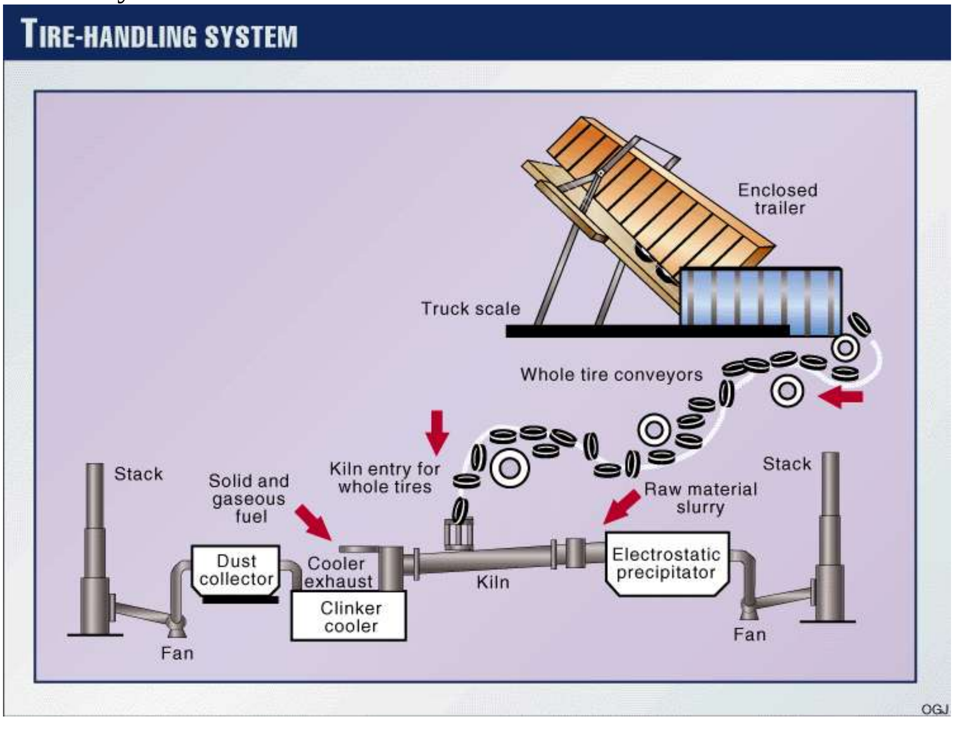
5. a. What are the raw materials used for the manufacture of Portland cement? Describe the manufacture of cement by wet process.
b . Explain the chemistry involved in setting and hardening of cement

a. Raw materials and functions
The raw material required for the manufacture of Portland cement are
1. Calcareous materials CaO (e.g. Limestone)
2. Argellaceous materials Al2O3 and SiO2 (e.g. Clay)
3. Powdered coal or fuel oil
4. Gypsum (CaSO4. 2H2O)
Functions of the ingredients in cement
1. Lime
Lime is the principle constituent of cement. Its proportion must be properly regulated. Excess of like reduces the strength of cement, because it makes the cement to expand and disintegrate. Lesser the amount of lime than required also reduces the strength of cement, because of quick-setting.
2. Silica
It imparts strength to cement
3. Alumina
It is responsible for the setting action of cement. Excess of alumina makes the cement quick-setting
4. Iron oxide
It provides colour, strength and hardness to the cement.
5. Sulphur trioxide
Presence of small amount of SO3 imparts soundness to cement. (The cement is said to be sound, if it resists the change in volume of already set concrete. The unsoundness of cement causes the disintegration of concrete.) Excess of SO3 makes the cement unsoundness.
6. Gypsum
It acts as a retarding agent for quick setting of cement.
Manufacture of Portland cement
Manufacture of Portland cement involves the following four major operations.
1. Mixing of raw materials
2. Burning
3. Grinding
4. Storage and packing
1. Mixing of raw materials – Wet process
The calcareous material (limestonea0 is crushed, powdered and stored in a storage tank (called silos). The argillaceous material (clay) is thoroughly washed with water to remove any adhering

organic matter and stored in a basin. Then the powdered limestone (from silos) and wet-clay (from basin) are led to "grinding mills", where they are mixed to form a paste called "Slurry". The slurry is led to a "Correcting basin" where its chemical composition may be adjusted. Thus the slurry containing about 38 to40% water is stored in storage tank

2. Burning

Burning of "slurry" is carried out in rotary kiln. The rotary kiln is a long horizontal steel cylinder (2.5.3.0 m dia and 90 to 120 m length) lined inside with refractory bricks, which rotates at a speed of 1 r.p.m. The kiln is set in slightly inclined position of about 5-6 to allow the material to travel slowly from one end to the another end.



Process

The "corrected slurry" is fed into the kiln from the upper end, while the hot flame is forced into the kiln from the lower end. Due to slope and slow rotation, the material gradually descends in the kiln into different zones of increasing temperatures.

i) Drying Zone

The upper part of the kiln is known as drying zone, where the temperature is about 400c. In this zone, most of the water in the slurry gets evaporated.

ii) Calcination zone

The central part of the kiln is known as calcinations zone where the temperature is about 1000C. In this zone, limestone gets decomposed into CaO and CO_2

$CaCO_3$ → CaO + $CO_2\uparrow$

Limestone   Quick lime

iii) Clinkering zone

The lowest part of the kiln is known as clinkering zone, where the temperature is about 1350-1500C. In this zone lime reacts with clay (containing $Al_2O_3.SiO_2.Fe_2O_3$) to form various Bogue compounds ($C_2S.C_3S$,C_3A, C_4AF)

$2CaO + SiO_2 \rightarrow 2CaO.SiO_2\ (C_2S)$

$3CaO + SiO_2 \rightarrow 3CaO.SiO_2\ (C_3S)$

$3CaO + Al_2O_3 \rightarrow 3CaO.\ Al_2O_3\ (C_3A)$

$4CaO + Al_2O_3 + Fe_2O_3 \rightarrow 4\ CaO.\ Al_2O_3.\ Fe_2O_3\ (C_4AF)$

These Bogue compounds fuse together to form small, hard, grayish coloured stone like mass called cement clinkers.

3. Grinding

The hot clinkers are cooled with atmospheric air and then pulverized together with 2-3% gypsum in ball mills. Gypsum acts as a retarding agent for quick setting of cement.

4. Storage and packing

The cement coming out of the grinding mill is stored in a concrete storage silos. Then the cement is packed in jute bags by automatic machine.

b.. Setting and hardening of cement

When the cement is mixed with water, hydration and hydrolysis reactions of Bogue compounds of cement begin, resulting in the formation of gel and crystalline products. The insoluble gels and crystals have the ability to surround inert materials like sand, bricks, crushed stones etc

Setting

It is defined as the stiffening of the original plastic mass, due to the formation of tobermonite gel

Hardening

It is defined as the development of strength due to formation of crystals.

Chemical reactions involved in setting and hardening of cement.

i) When the cement is mixed with water, at first, hydration of tricalcium aluminate (C3A) takes place rapidly (within 1 day) and the paste becomes quite rigid within a short time which is known as initial set or flash set.

$3CaO.\ Al_2O_3 + 6H_2O \rightarrow 3CaO.\ Al_2O_3.6H_2O + 880\ KJ/Kg$

Tricalciumaluminate Hydrated tricalcium aluminate (crystalline)

(Or)

$C_3A + 6H_2O \rightarrow C_3A.\ 6H_2O$

In order to retard the rapid hydration of C_3A (early initial setting), gypsum is added during grinding of cement clinkers. Gypsum reacts with C_3A to give insoluble calcium sulpho aluminate complex ($3CaO.\ Al_2O_3CaSO_4.\ 2H_2O$). which does not possess hydrating property and retards early setting of cement.

$C_3A + 3CaSO_4.\ 2H_2O \rightarrow C_3A.\ 3CaSO_4.\ 2H_2O$

Calcium sulpho aluminate

ii) After the hydration of C_3A, C_3S begins to hydrate to give tobermonite gel and crystalline $Ca(OH)_2$. This is responsible for the development of initial strength of cement. The hydration of C3S gets completed within7days. It does not contribute much to the strength of cement.

$2[3CaO.\ SiO_2] + 6H_2O \rightarrow 3CaO.2SiO_2.3H_2O + 3Ca(OH)_2 + 500\ KJ/Kg$

Tricalcium silicate Tobermonite gel Crystalline

(or)

$2C_3S + 6H_2O \rightarrow C_3S_2.\ 3H_2O + 3Ca(OH)_2$

Note: Tobermonite gel possesses a very high surface area and very high adhesive property.

iii) Dicalcium silicate (C_2S) reacts with water very slowly and gets completed in 7 to 28 days.

$2(2CaO.SiO_2) + 4H_2O \rightarrow 3CaO.SiO_2.\ 3H_2O + Ca(OH)_2 + 250\ KJ/Kg$

Dicalcium silicate Tobermonite gel Crystalline

(Or)

$2C_2S + 4\ H_2O \rightarrow C_3S_2.3H_2O + Ca(OH)_2$

The increase in strength between 7 to 28 days is due to the formation of tobermonite gel and crystalline $Ca(OH)_2$ of both C_2S and C_3S.

iv) Though the hydration of tetracalcium alumino ferrite (C_4AF) takes place initially, the hardening takes place finally through crystallization, along with C_2S.

$4CaO.Al_2O_3.Fe_2O_3 + 7H_2O \rightarrow 3CaO.Al_2O_3.6H_2O + CaO.Fe_2O_3.H_2O + 420\ KJ/Kg$

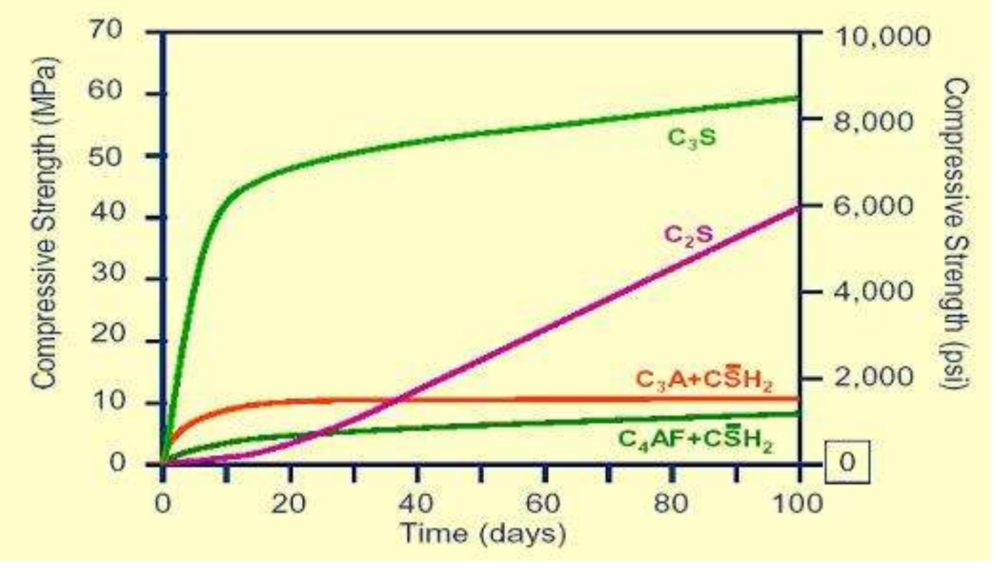
Tetracalcium alumino ferrite Crystalline Gel

(Or)

$C_4AF + 7H_2O \rightarrow C_3A.6H_2O$

Thus, the final setting and hardening of cement is due to the formation of tobermonite gel plus crystallization of $Ca(OH)_2$ and hydrated tricalcium aluminate.

Development of compressive strength of the cement, due to hydration and hydrolysis of Bogue compounds, are shown in the graph.2



6. a. Explain the process of manufacture of glass
b. List out the general properties of glass.

a. Raw materials used in the manufacture of glass

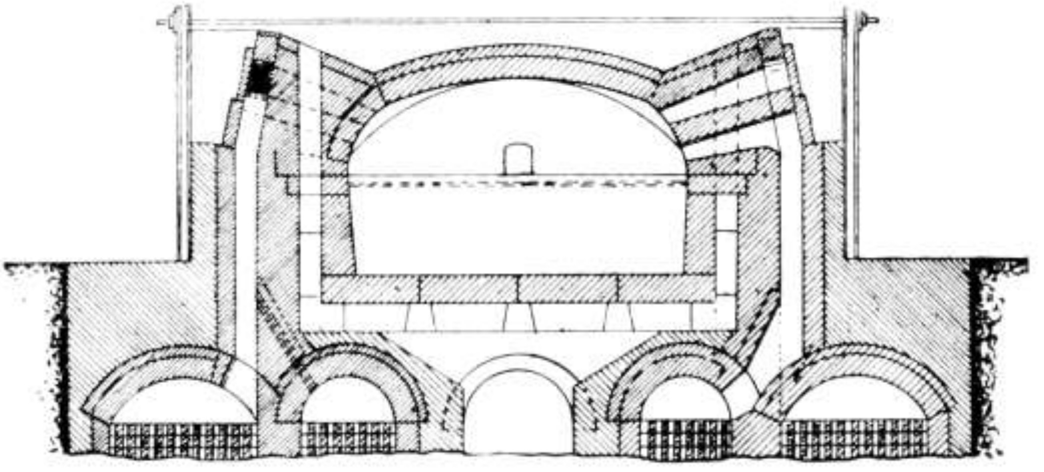
S.No	Name of the element	Source of the element	Name of the glass produced
1	Sodium(Na)	Na_2CO_3,Na_2SO_4	Soft glass
2	Potassium(K)	Potash,K_2CO_3,KNO_3	Hard glass
3	Calcium(Ca)	Lime,limestone	
4	Barium(Ba)	$BaCO_3$	
5	Lead	Litharge, red lead	Flint glass
6	Zinc	ZnO	Heat and shock proof glass
7	Borate	Borax,Boric acid	Heat and shock proof glass
8	Silica	Sand,Quartz	
	Colour i)Yellow Ferric salt ii)Green Ferrous and chromium salt iii)Blue Cobalt salt		

Manufacture of glass:

It involves four steps

Step 1 Melting:

The raw materials in proper proportions (e.g sand,soda ash,and lime stone for common glass) are mixed and finely powedered. The homogeneous mixture (known as Batch) is fused with some broken glass caleed “cullet” in the pot (or) tank of the tank furnace, in which heating is done by burning producer gas and air mixture over the charge.



Air fuel gas flue gases

The cullet melts at a comparatively low temperature and assists in melting the rest of the charge. During melting of ordinary soda glass, the following series of reactions occur. The reaction is an acid – base reaction leading to the formation of various silicates.

$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2\uparrow$

$Na_2CO_3 + SiO_2 \rightarrow Na_2SiO_3 + CO_2\uparrow$

Step 2 Working of molten glass:

The molten glass is then worked into articles of desired shapes by either blowing or moulding or pressing between rollers.

Step 3 Annealing:

Glass articles are then allowed to cool gradual to room temperature(sudden cooling must be avoided, because cracking occurs.) The longer the annealing period, the better is the quality of the glass.

Step 4 Finishing:

The glass articles, after annealing period ,are subjected to finishing process such as cleaning, polishing, cutting, sand – blasting etc.

b. **General properties of glasses**

1. It is amorphous.
2. It has no definite melting-point.
3. It is very brittle.
4. It softens on heating.
5. It is affected by alkalis.
6. It can absorb, reflect or transmit light.
7. It is a good electrical insulator.
8. It is not affected by air, water, or acids, or chemical reagents, but soluble in HF, which converts its silica into SiF_4
9. Since it has no crystalline structure, no sliipage between planes can occur, It possesses high compressive strength.
10. It is light, because it has homogeneous internal structure similar to liquids.

7. How are the following glasses made and write their composition, properties and uses (i) Flint glass (ii) Pyrex glass (iii) Alumino silicate glass (iv) Crookes glass (v) Opal glass (vi) Soft glass

(i) Lead glass or flint glass

Raw Materials

Lead oxide (instead of calcium oxide) and silica are fused.

For dense optical glasses, as much as 80% of PbO is incorporated. In addition of K_2O is used, instead of sodium oxide.

Composition

The approximate composition is $K_2O.PbO.\ 6SiO_2$

Properties

1.It is bright, lustrous and possesses high specific gravity (3 to 3.3)
2. It is more expensive to manufacture, than the ordinary lime-soda glass.
3. It has a lower softening temperature than soda-glass.
4. It has higher refractive-index and excellent electrical properties.

Uses

1. Lead glasses are used for high quality table wares, neon sign tubings, optical purposes (like lenses etc), electrical insulators.
2. High lead content glasses are used for extra-dense optical glasses for windows and shields to protect personnel from X-rays and gamma-rays in medical and atomic energy fields respectively.

(ii)Boro Silicate glass or pyrex glass or Jena glass.

Raw materials

Silica, boron with a small amount of alumina and some oxides.

Composition

A typical formula for the glass is
SiO_2 (80.5%), B_2O_3(13%), Al_2O_3(3%), K_2O(3%) and Na_2O (0.5%)

Properties

1. The substitution of alkali (Na_2O) and basic alkaline earth oxides (CaO) of the soda glasses by boron and aluminium oxides results in a low thermal coefficient of expansion and high chemical resistance.
2. It possesses very high softening points and excellent resistivity (shock proof)

Uses

It is used in industry for pipelines for corrosive liquids, gauge glasses, superior laboratory apparatus, kitchen wares, television tubes, chemical plants, electrical insulators.

(iii)Alumino Silicate glass

Raw material

It contains 5% or more of alumina. Addition of alumina makes the glass heat resistant.

Composition

The composition of this glass is
SiO_2 (55%), Al_2O_3(23%), B_2O_3(7%), MgO(9%), CaO(5%), $Na_2O + K_2O$(1%)

Properties

They possess exceptionally high softening temperatures.

Uses

They are used in high-pressure mercury discharge tubes, chemical combustion tubes, certain domestic equipments. Etc

(iv) Optical or Crookes glass

Raw Material

Contain phosphorus and lead silicate together with a small amount of cerium oxide. Cerium oxide is capable of absorbing UV light (Which is injurious to eyes)

Properties

1. Optical glasses have low melting-points and are relatively soft.
2. Chemical-resistance and durability of optical glasses are lower than those of ordinary glasses

Uses

Optical glasses are used for making lenses
filaments of glass. They are completely alkali free.
The glass filaments are obtained by forcing molten glasses through small

(v) Opal glasses

Raw Material

NaF (or) CaF_2 (or) $Ca_3(PO_4)_2$ (or) SnO_2

Properties

They are translucent white or milky glasses. They are transparent, when they are in liquid, but becomes opalescent, when they are cooled, because of inclusions

(vi).Soda lime (or) Soft glass

Raw Materials

Silica (sand), calcium carbonate and soda ash.

Composition

The approximate composition is

Na_2O. CaO.6SiO_2

Properties

1. They are low cost.
2. It is resistant to water.
3. It is attacked by common reagents like acids.

Uses

They are used as window glasses, electric bulbs, bottles, plate-glasses, jars, cheaper table wares, where high temperature-resistance and chemical stability are not required.