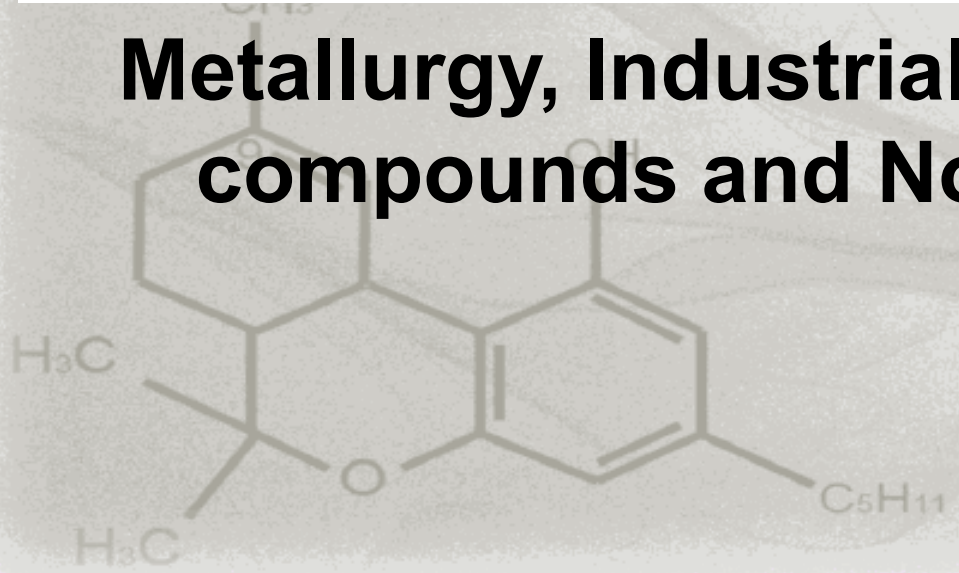
Inorganic chemistry

Metallurgy, Industrially important compounds and Noble gases



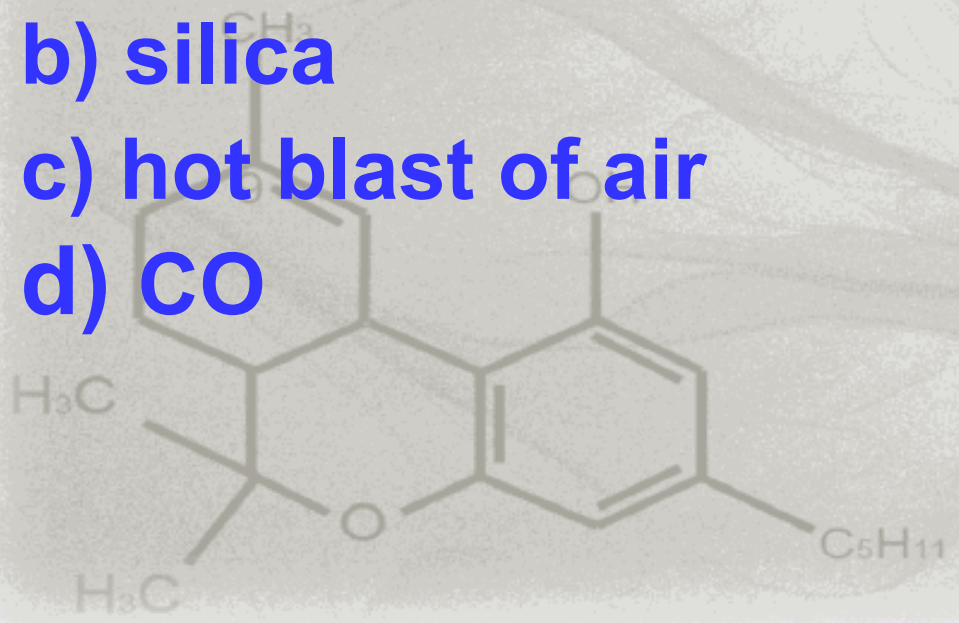
Q1. In blast furnace, iron oxide is reduced by

a) carbon

b) silica

c) hot blast of air

d) CO



Option d

In smelting of iron ore, though coke is added, CO is the reducing agent. In the furnace, iron ore is introduced from the top and at the temperature 600-700^{o}C large amount of Fe_2O_3 is reduced to iron by CO. also a/c to Ellingham diagram CO is the actual reducing agent.

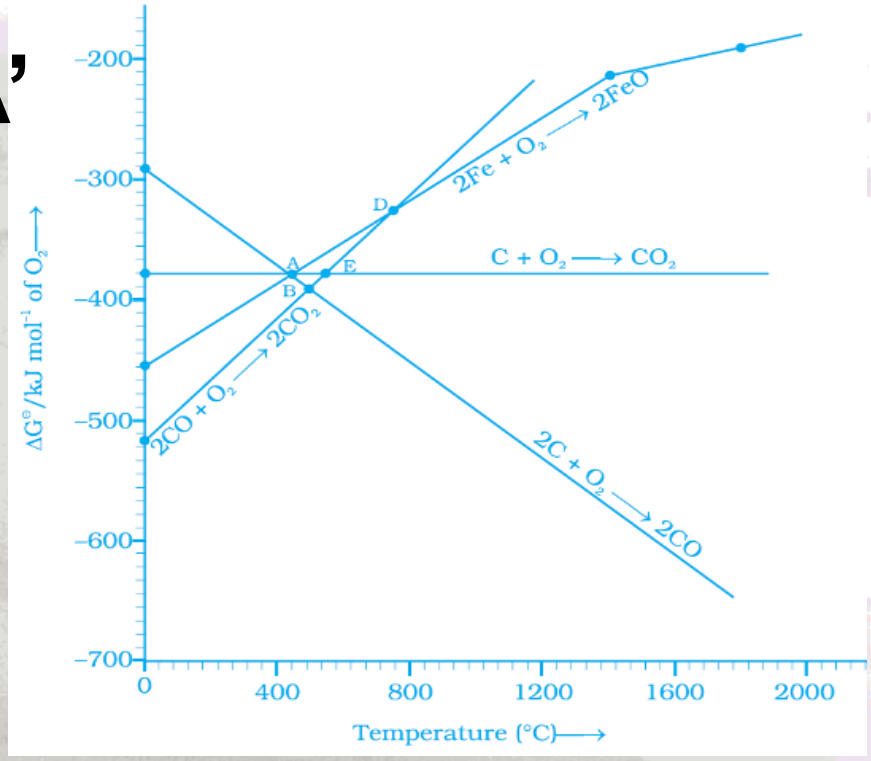
Q2. Below point 'A' FeO can

a) be reduced by CO only

b) be reduced by both C and CO

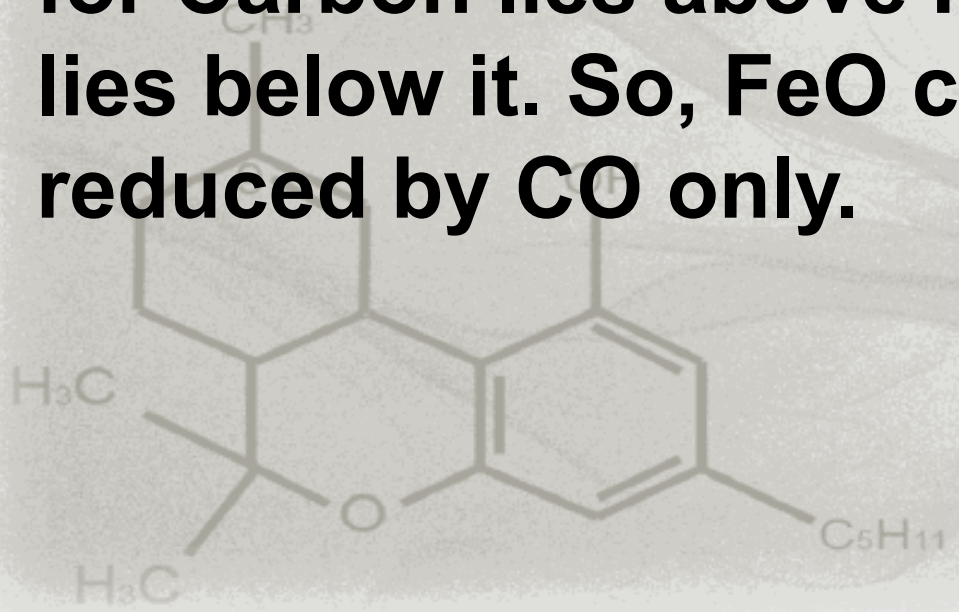
c) be reduced by C only.

d) not be reduced by both C and CO.



Option a

From the Ellingham diagram it is clear below point A that the line for Carbon lies above FeO and CO lies below it. So, FeO can be reduced by CO only.



Q3. ΔG^o Vs T plot in Ellingham diagram slope downwards for the reaction

a) $CO + \frac{1}{2} O_2 \rightarrow CO_2$

b) $C + \frac{1}{2} O_2 \rightarrow CO$

c) $2Ag + \frac{1}{2} O_2 \rightarrow 2AgO$

d) $Mg + \frac{1}{2} O_2 \rightarrow MgO$

Option b

Generally lines in Ellingham diagram slope upwards except for one reaction i.e $2C + O_2 \rightarrow 2CO$. ΔS for this reaction becomes +ve. Then ΔG as per the equation $\Delta G = \Delta H - T\Delta S$ will become more and more –ve as temperature increases hence it slopes down.

Q4. Which of the following reactions taking place in blast furnace is endothermic

a) $Fe_2O_3 + 3CO \rightarrow Fe + 3CO_2$

b) $C + O_2 \rightarrow CO_2$

c) $2C + 2O_2 \rightarrow 2CO_2$

d) $CaCO_3 \rightarrow CaO + CO_2$

Option d

The reactions in blast furnace are

$C + O_2 \rightarrow CO_2$ &

$2\ Fe_2O_3 + 3CO \rightarrow Fe + 3CO_2$

Combustion and reduction reactions are exothermic

$CO_2 + C \rightarrow 2CO$ & $CaCO_3 \rightarrow CaO + CO_2$

While formation of CO and decomposition of $CaCO_3$ are endothermic.

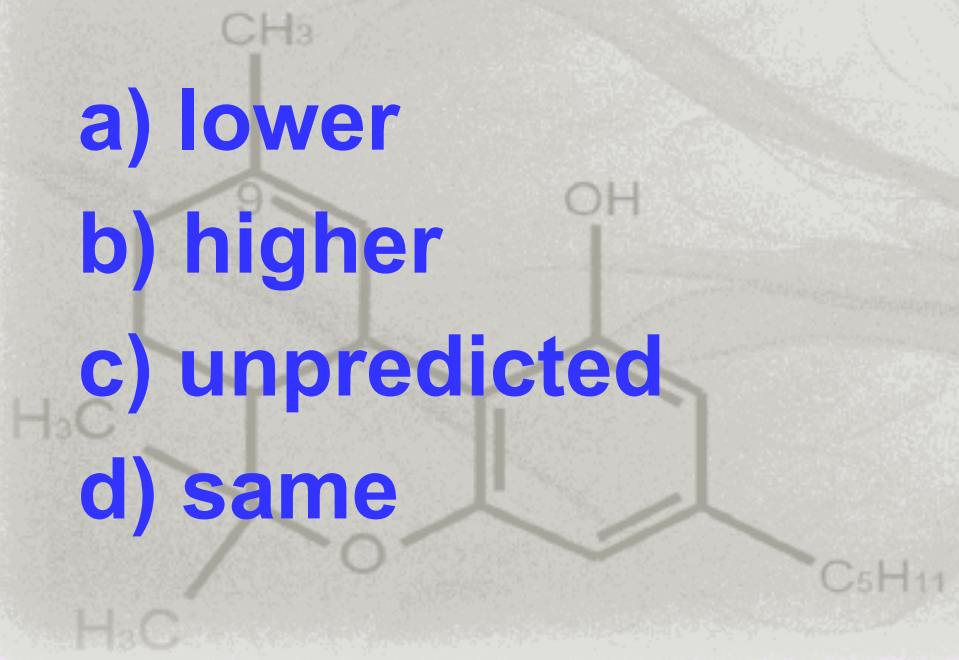
Q5. When compared to ΔG^{o} for the formation of Al_2O_3, ΔG^{o} for the formation of Cr_2O_3 is

a) lower

b) higher

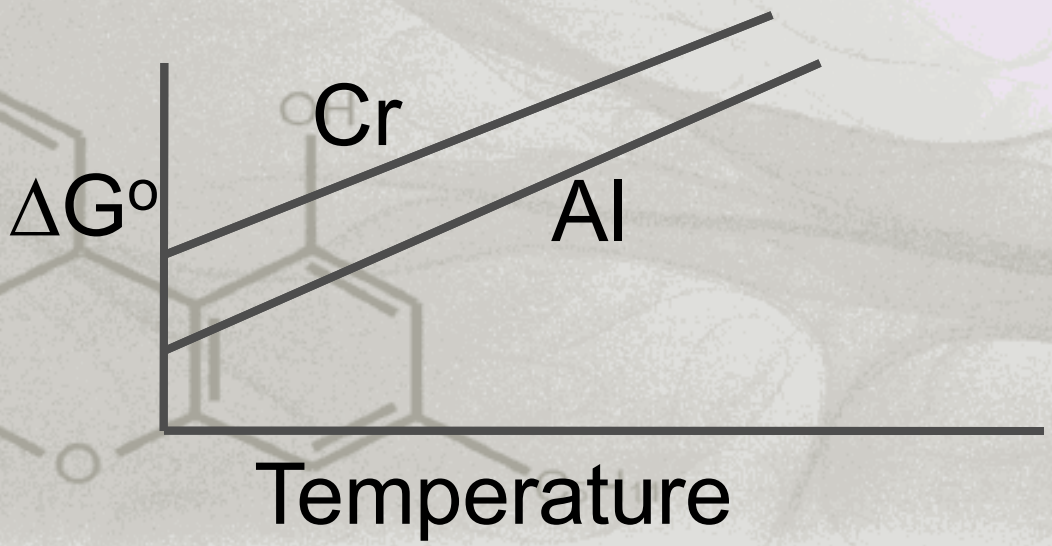
c) unpredicted

d) same



Option b

Ellingham diagram for aluminium and chromium is as given below. We can see that line for Al_2O_3 lies below Cr_2O_3 ,that means it has higher ΔG^o value



Q6. Identify the reaction that does not take place in blast furnace

a) $CaO + SiO_2 \rightarrow CaSiO_3$

b) $CaCO_3 \rightarrow CaO + CO_2$

c) $CO_2 + C \rightarrow 2CO$

d) $FeCO_3 \rightarrow FeO + CO_2$

Option d

a.) $CaO + SiO_2 \rightarrow CaSiO_3$
is slag formation

b.) $CaCO_3 \rightarrow CaO + CO_2$
is decomposition

c.) $CO_2 + C \rightarrow 2CO$
heat absorption

These happen in blast furnace

d.) $FeCO_3 \rightarrow FeO + CO_2$ happens during roasting

Q7.Carbon can reduce Fe_2O_3 to iron at a temperature above 983K because

a) free energy for the formation of CO_2 is less negative than that for Fe_2O_3.

b) Fe has a higher affinity for O_2 than C

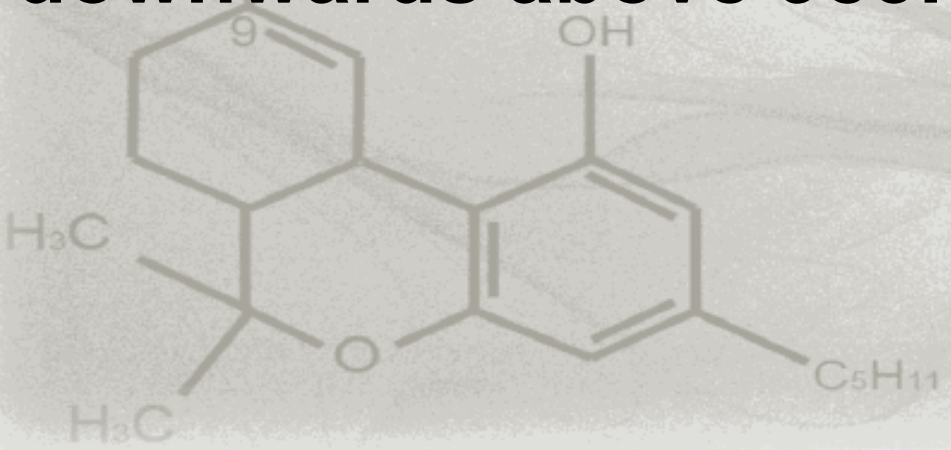
c) CO affinity for O_2 is more than carbon

d) Carbon has higher affinity for oxygen than iron

option d

All the first three options are correct but not above 983K

From Ellingham diagram it is clear the line of Carbon oxidation slopes downwards above 983K.



Q8. Distribution law does not hold good when

a) temperature is kept constant

b) the solutions are concentrated

c) molecular state of solute remains unchanged in both the phases

d) C_1 and C_2 are the equilibrium concentrations

option b

The law states, distribution is at constant temperature.

Molecular state should not change means the molecules should not undergo association or dissociation.

The distribution happens till the equilibrium is reached. i.e the solute dissolves till the ratio of concentration is a constant. But all these happen only in dilute solutions i.e with more solvent.

Q9. Which of the following is not correct

a) when molten Pb & Zn are mixed molten Zn forms the upper layer

b) Ag is more soluble in molten Pb than in molten Zn

c) Zn-Ag alloy solidifies earlier than the molten Pb

d) Zn can be separated from Ag by distillation

Option b is the incorrect statement

We know that distribution coefficient of silver between zinc and lead is 300 at 800^{o}C .

This means silver is more soluble in zinc than in lead.

All other options are correct. Infact, the purpose of choosing zinc for Parke's process is that, it is lighter, forms alloy with silver, solidifies quickly and can be distilled off easily.

Q10. The smelting of iron in blast furnace involves all the processes except

a) combustion

b) reduction

c) slag formation

d) sublimation

Option d

It is very clear by now that all the given processes happen in blast furnace except sublimation.
Sublimation is changing solid to vapour directly without forming a liquid.
Ex. Camphor, naphthalene balls.

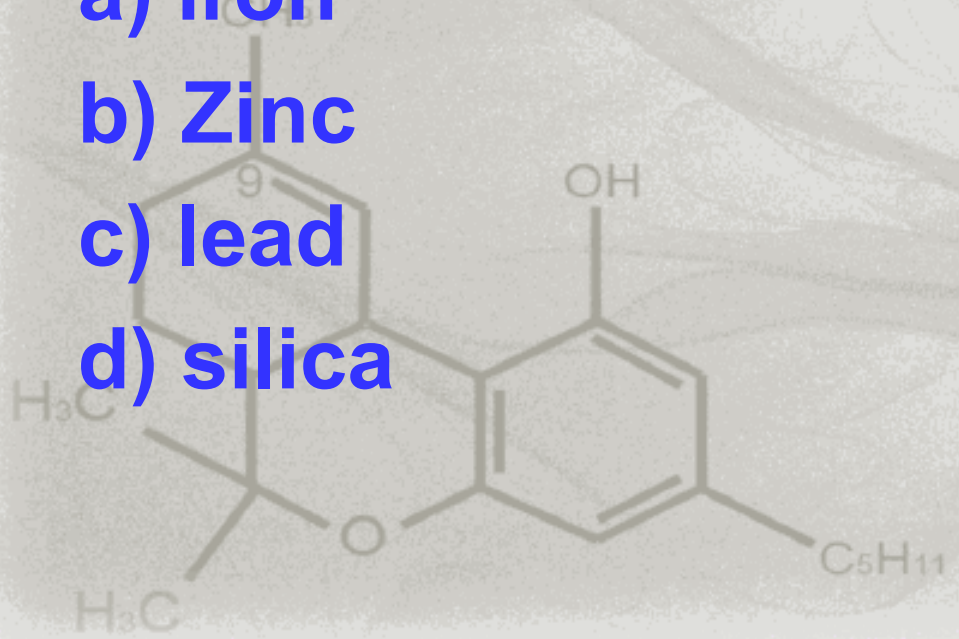
Q11. Silver is refined by cupellation to remove

a) iron

b) Zinc

c) lead

d) silica



Option c

Final step of extraction of silver is refining. Zinc is removed during distillation but traces of lead which have come along with the Zn-Ag alloy when removed by perforated laddles are removed during cupellation.

Q12. P_4O_{10} is not used to dry NH_3 because

a) P_4O_{10} is basic and NH_3 is acidic

b) P_4O_{10} is acidic and NH_3 is basic

c) P_4O_{10} is not a drying agent

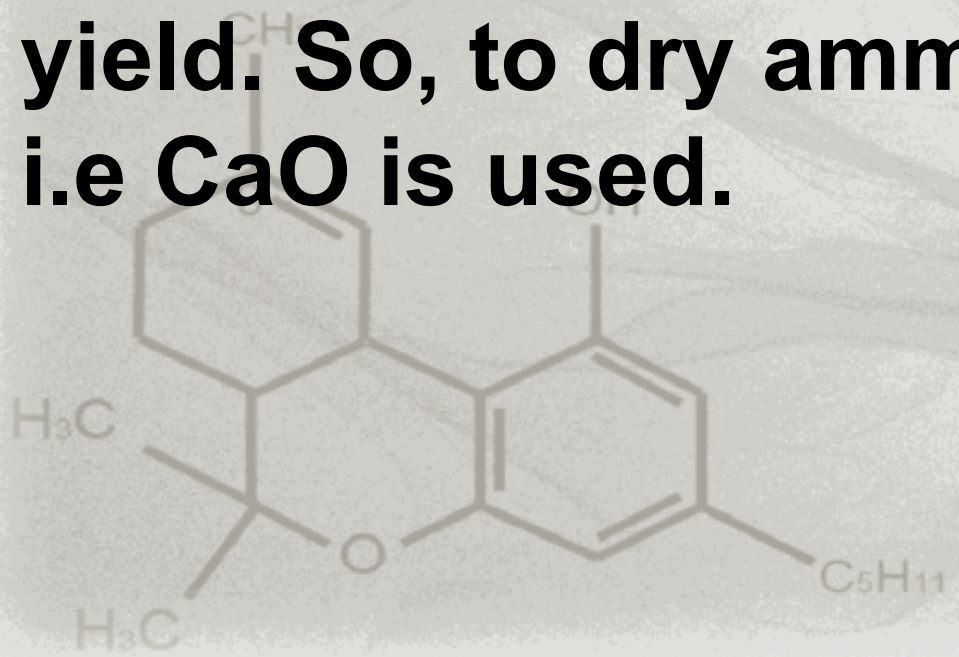
d) P_4O_{10} reacts with moisture in NH_3

Option b

We Know that P_4O_{10} is a dehydrating agent i.e it removes water.

But in the manufacture of ammonia we cannot use P_4O_{10} to dry ammonia because P_4O_{10} being acidic reacts with formed ammonia which is basic.

Even conc. H_2SO_4 and anhydrous $CaCl_2$ cannot be used because both react with ammonia. We will lose the yield. So, to dry ammonia quick lime i.e CaO is used.



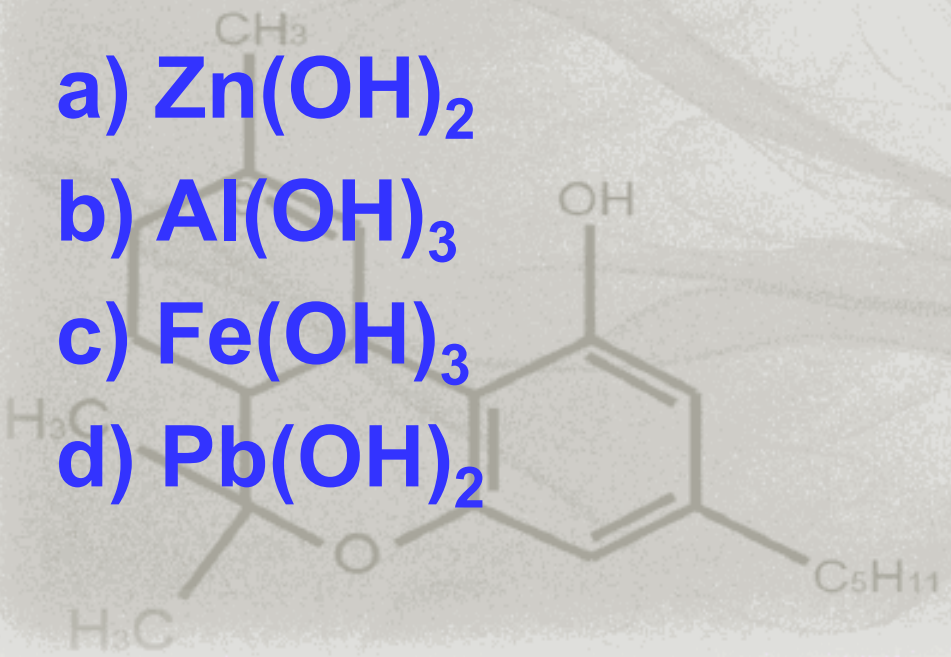
Q13. Which of the following metallic hydroxides does not dissolve in NaOH solution

a) $Zn(OH)_2$

b) $Al(OH)_3$

c) $Fe(OH)_3$

d) $Pb(OH)_2$



Option c

Ferric hydroxide will not dissolve in NaOH, whereas hydroxides of Zinc, Aluminium, Tin and Lead dissolve in NaOH giving sodium zincate, sodium aluminate, sodium stannate and sodium plumbate respectively.

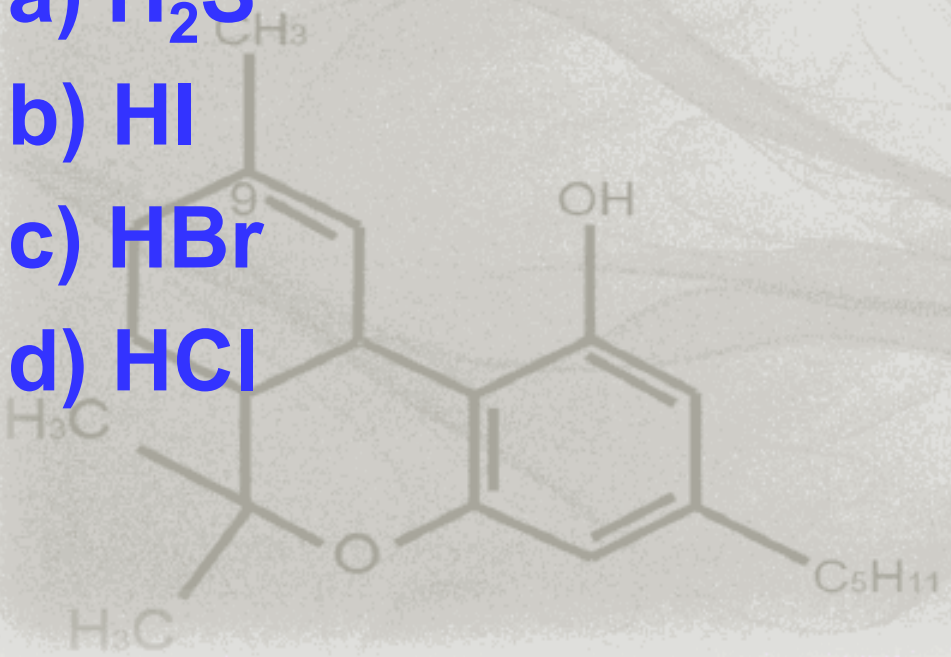
Q14. Which one of the following is not affected by conc H_2SO_4

a) H_2S

b) HI

c) HBr

d) HCl



Option d

HBr and HI gets oxidised by H_2SO_4 to Br_2 & I_2. H_2S is oxidised to S (H_2SO_4 is not used to dry H_2S). But H_2SO_4 is not strong enough to oxidise HCl. i.e it is unaffected.

Note:H_2SO_4 displaces HCl from chlorides because HCl is more volatile than H_2SO_4.

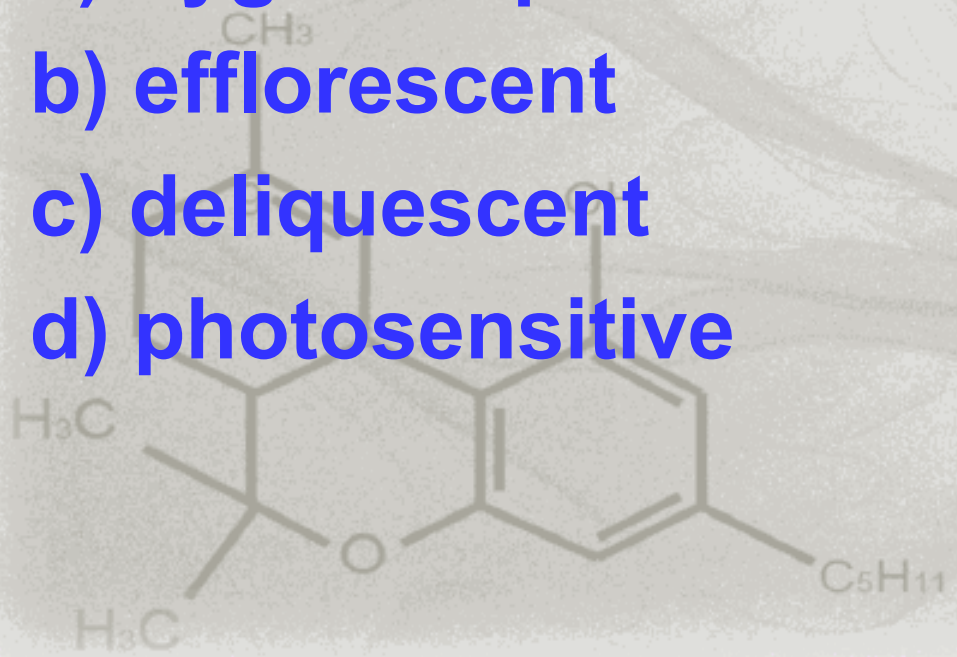
Q15. NaOH is

a) hygroscopic

b) efflorescent

c) deliquescent

d) photosensitive



Option c

Hygroscopic means absorbing moisture from air, a dessicant like silica gel, Anhyd $CaCl_2$.

Efflorescent means loss of water by a hydrate when exposed to air.

Ex. washing soda $Na_2CO_3.10H_2O$

Deliquescent is absorbing moisture and dissolving in it. Ex. NaOH

Photosensitive is sensitive to light.

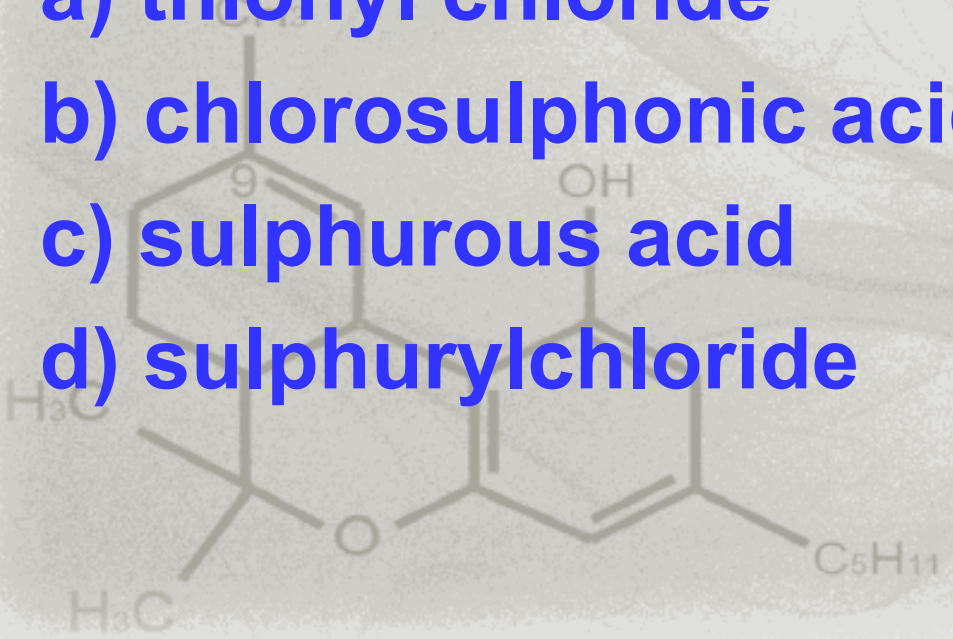
Q16. Excess of PCl_5 reacts with conc H_2SO_4 giving

a) thionyl chloride

b) chlorosulphonic acid

c) sulphurous acid

d) sulphurylchloride



Option d

PCl_5 is a reagent used to remove -OH group and introduce –Cl in its place. so sulphuric acid is $SO_2(OH)_2$ with PCl_5 will give SO_2Cl_2 which is sulphuryl chloride

Thionylchloride = $SOCl_2$
Chlorsulphonic acid = $ClSO_3H$
Sulphurous acid = H_2SO_3

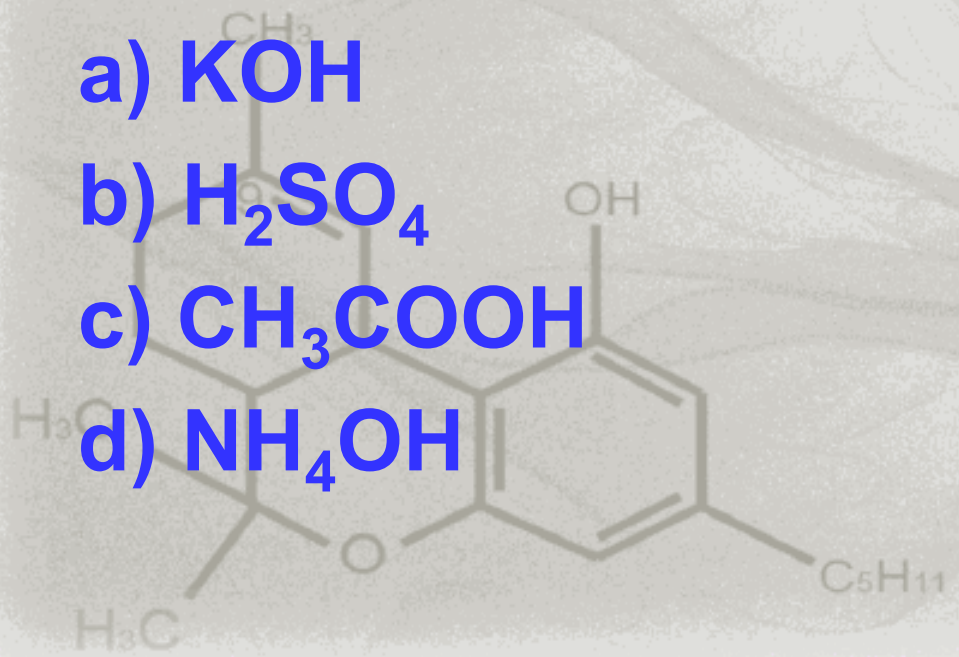
Q17. Potassium chromate is converted to potassium dichromate by adding

a) KOH

b) H_2SO_4

c) CH_3COOH

d) NH_4OH



Option b

$K_2Cr_2O_7$ and K_2CrO_4 are in equilibrium as given $Cr_2O_7^{-2} + H_2O \rightleftharpoons 2CrO_4^{-2} + 2H^+$

When base (OH^-) is added equilibrium shifts towards chromate and when acid is added it shifts towards dichromate. So, strong acid is added.

Note: Here oxidation number of chromium does not change, it is +6 in both.

Q18. The function of $Fe(OH)_3$ in the contact process of manufacture of sulphuric acid is

a) to remove moisture

b) to remove dust particles

c) to remove arsenic impurites

d) to detect colloidal impurity

Option c

- To remove moisture-Drier - quartz.
- To remove dust particles- Dust chamber - steam is injected.
- To remove arsenic impurites – Arsenic purifier - $Fe(OH)_3$
- To detect colloidal impurity – Tyndall box

Q19. In electrolysis of brine in Nelson cell, the cathode & anode are separated by a diaphragm to

a) prevent the reaction between NaOH & Cl_2

b) increase the yield of products

c) prevent mixing of NaCl and NaOH

d) prevent the reaction between Na and Cl_2

Option a

Diaphragm is used to prevent Cl_2 from coming in contact with NaOH solution which will otherwise form NaCl and NaOCl.

Option C is not possible because it does not matter even if they mix they give the same ions.

Option d *is not possible since we are using aq* NaCl

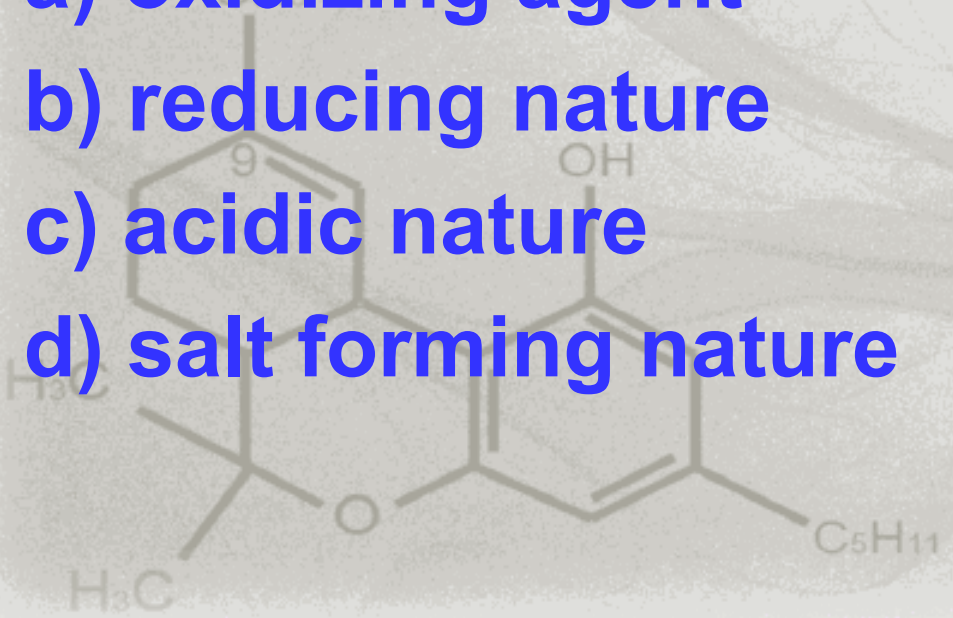
Q20. Which of the following properties are not associated with both dilute and conc H_2SO_4

a) oxidizing agent

b) reducing nature

c) acidic nature

d) salt forming nature



Option b

Reducing nature is not associated with sulphuric acid.

A reducing agent is the one which gives electrons i.e undergoes oxidation but sulphur in sulphuric acid is already in maximum oxidation state of +6. It cannot oxidise or give electrons further.

Q21. Which of the following is true

a) NaOH solution does not react with Cl_2

b) manganous hydroxide is soluble in excess of NaOH solution

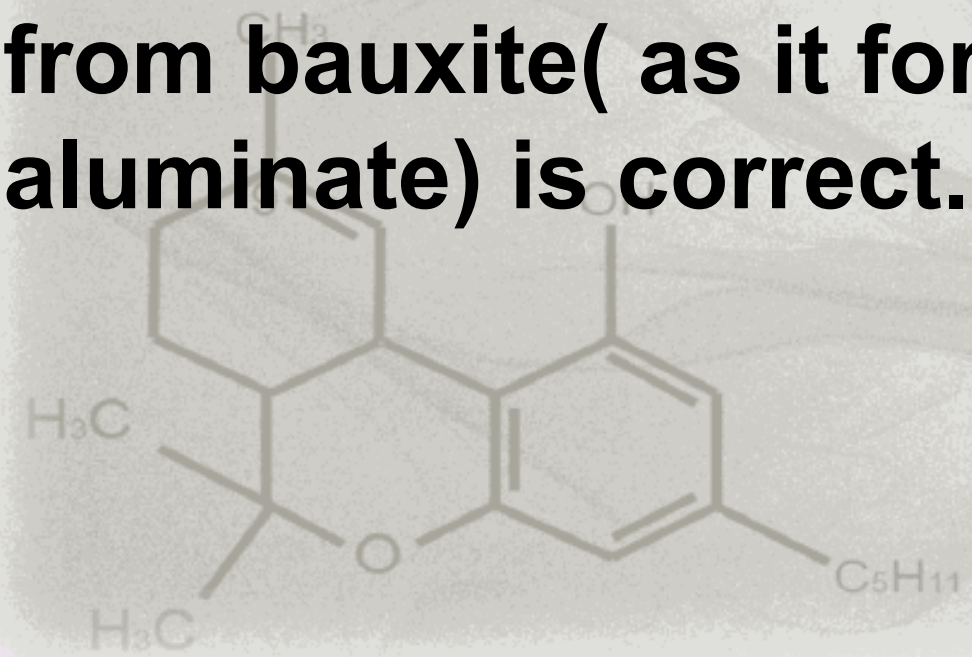
c) NaOH is a primary standard

d) NaOH is used in concentration of bauxite ore.

Option d

Statements in option a, b, c are wrong.

NaOH is used to remove gangue from bauxite(as it forms sodium aluminate) is correct.



Q22. The unfavourable condition for the manufacture of ammonia by Haber's process

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + 92.3kJ$$

a) increasing temperature

b) increasing pressure

c) reducing temperature

d) removing ammonia as on when it is formed

Option a

According to Lechatlier's principle lower temperature and high pressure favour the formation of ammonia as it is clear from the equation. Therefore increase in temperature is the unfavourable condition

Q23. When conc.H_2SO_4 is added to sugar, it gets charred. During this reaction H_2SO_4 acts as a/an

a) dehydrating agent

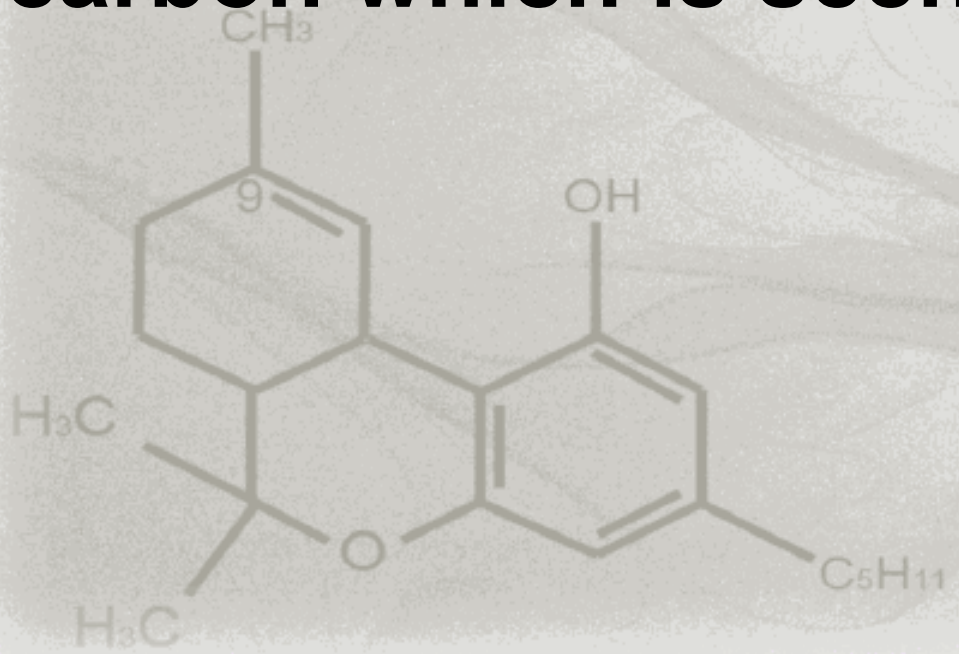
b) reducing agent

c) sulphonating agent

d) oxidising agent

Option a

As a dehydrating agent, since it removes water from sugar giving carbon which is seen as char



Q24. The lowest boiling point of Helium is due to

a) inertness

b) high polarisability

c) small size

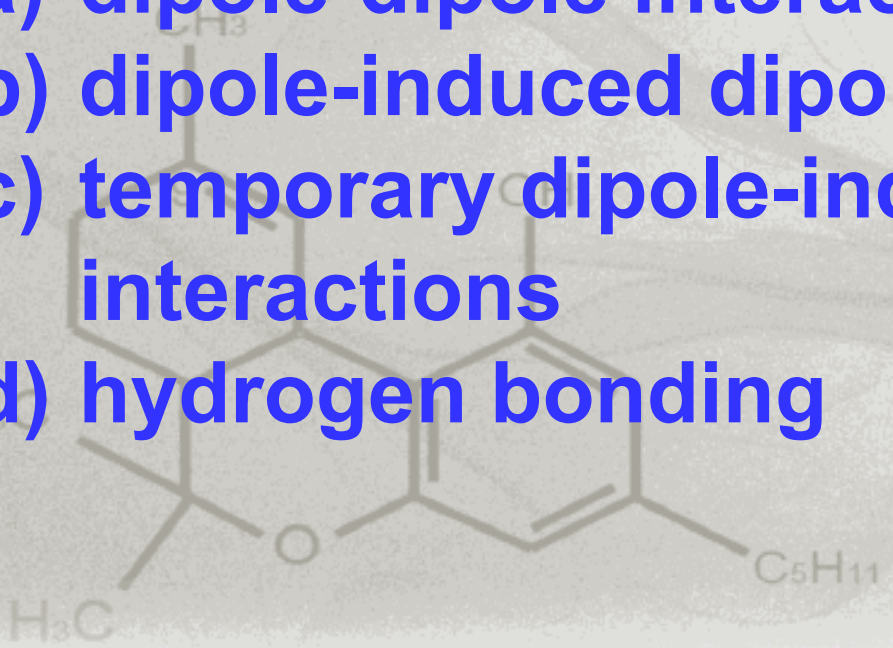
d) weak Vanderwaal's force between atoms

Option d

Vanderwaal's force depends on mass. Helium has lower mass, hence lower Vanderwaal's force. Therefore the temperature required to boil helium is also low. B.P increases down the group.

Q25. The solubility of noblegases in water is due to

a) dipole-dipole interactions
b) dipole-induced dipole interactions
c) temporary dipole-induced dipole interactions
d) hydrogen bonding



Option b

Noble gases are sparingly soluble in water due to dipole-induced dipole interactions. More polarisable gas will dissolve more. Solubility increases down the group. i.e Xenon is the most soluble

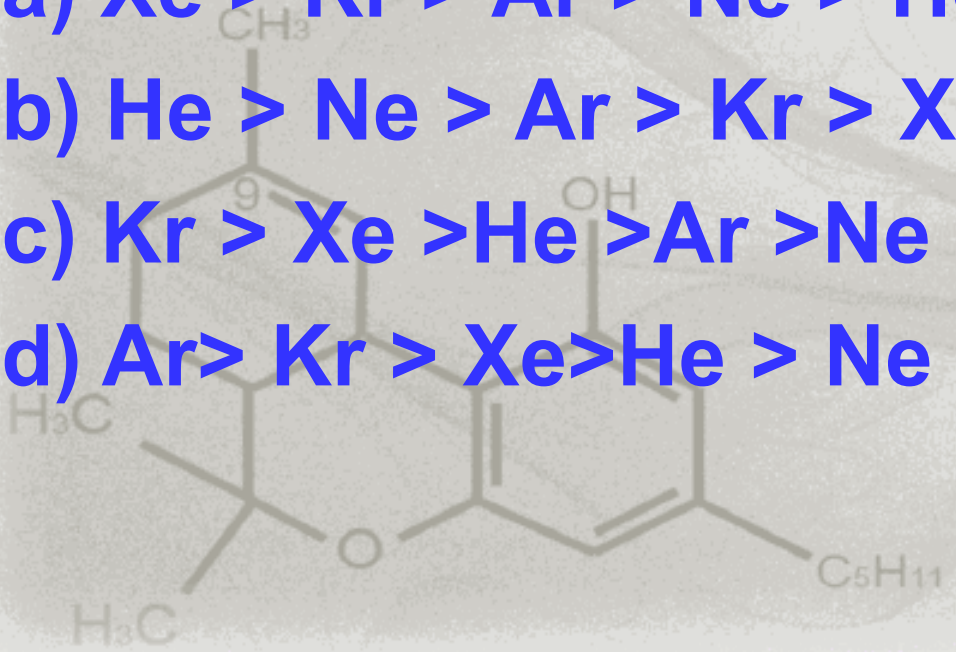
Q26.The ease of liquefaction of noble gases is in the order

a) Xe > Kr > Ar > Ne > He

b) He > Ne > Ar > Kr > Xe

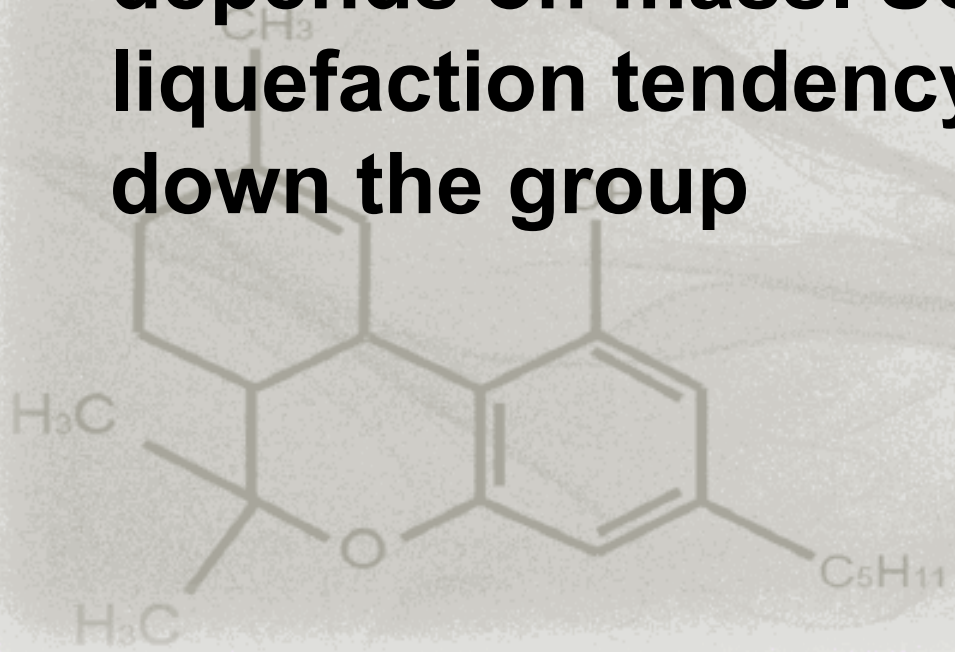
c) Kr > Xe >He >Ar >Ne

d) Ar> Kr > Xe>He > Ne



Option a

Liquefaction depends on the extent of Vanderwaal's force which in turn depends on mass. So the ease of liquefaction tendency increases down the group



Q27.The principle involved in the separation of noble gases by Dewar's method is that

a) noble gases are devoid by chemical reactivity

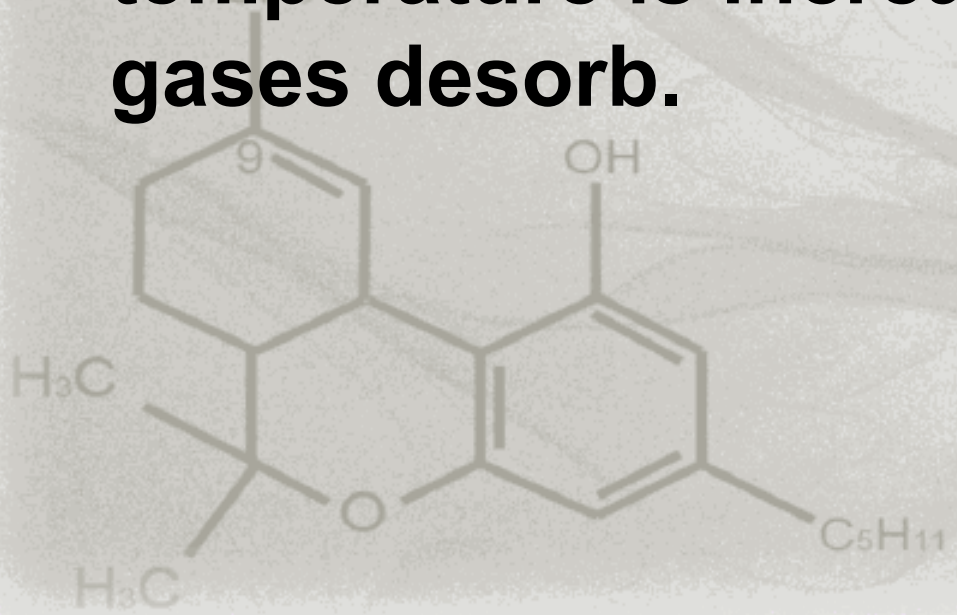
b) noble gases react differently with coconut charcoal at different temperatures

c) coconut charcoal adsorbs different noble gases at different temperatures

d) coconut charcoal is a good adsorbent for noble gases

Option c

At lower temperatures noble gas gets adsorbed on charcoal and as temperature is increased the gases desorb.



Q 28. The noble gas mixture is cooled in a coconut bulb at 173K. The gases that are not adsorbed are

a) Ne and Xe

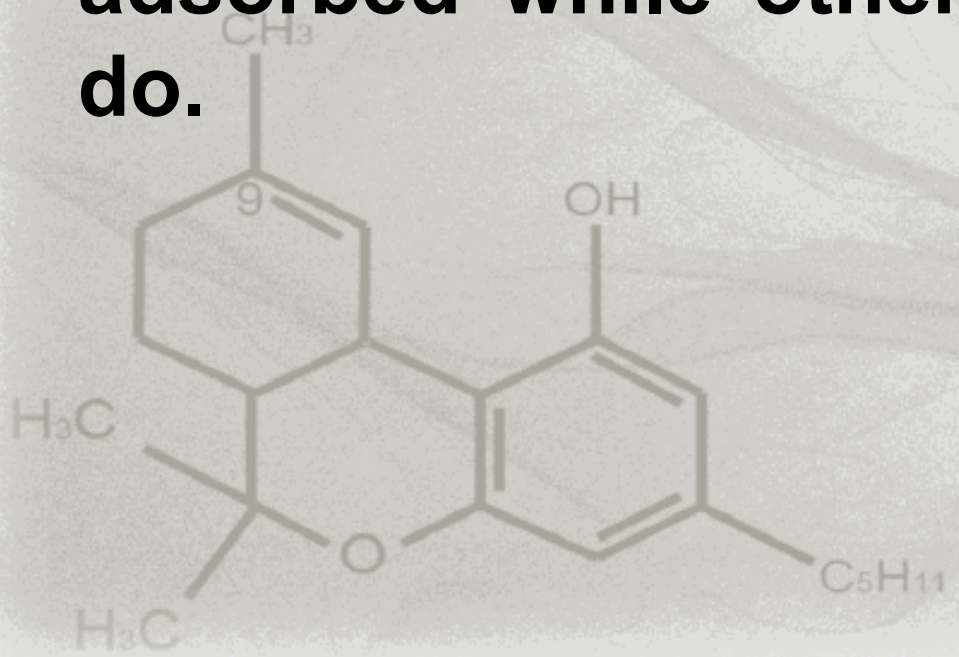
b) He and Xe

c) Ar and Kr

d) He and Ne

Option d

The first separation is done at 173K where He and Ne do not get adsorbed while other three gases do.



Q29. Which of the following reactions is not involved in the isolation of noble gases by Ramsay method

a) $2NO + O_2 \rightarrow 2NO_2$

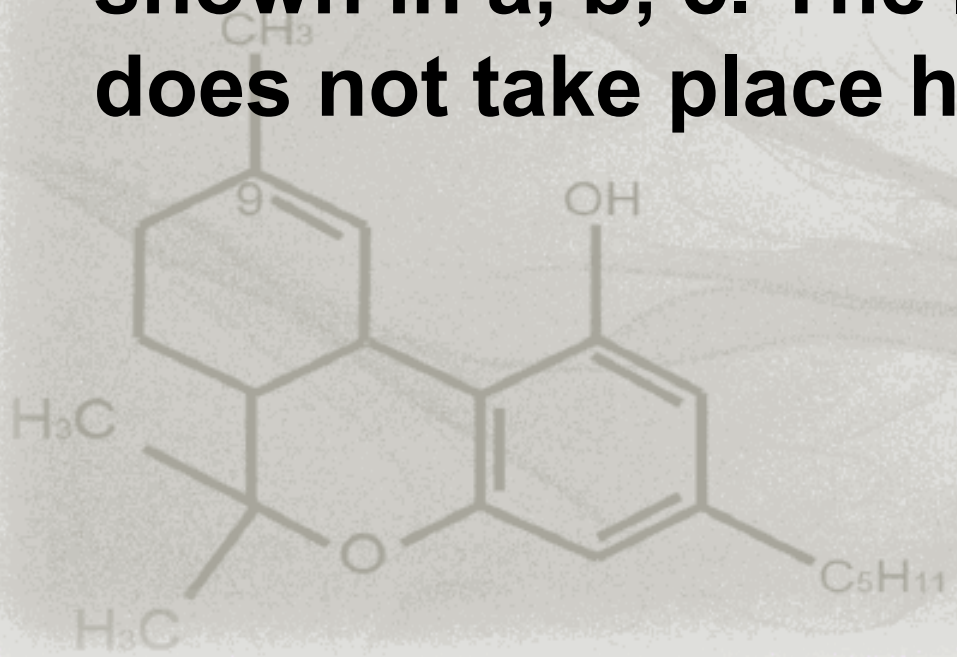
b) $2NO_2 + 2NaOH \rightarrow NaNO_2 + NaNO_3 + H_2O$

c) $N_2 + O_2 \rightarrow 2NO$

d) $N_2O_4 \rightarrow 2NO_2$

Option d

Nitrogen and oxygen are removed with NaOH as per the equations shown in a, b, c. The last reaction does not take place here.



Q30. Noble gases do not react with other elements because

a) They are monoatomic

b) They are not found in abundance

c) The size of their atoms are very small

d) They have completely paired up and stable electron shells

Option d

Noble gases are inert due their filled configuration. As a result the ionisation energy will be very high, electron affinity will be low. Only Xe ionisation energy can be reached and that too with elements like fluorine and oxygen.

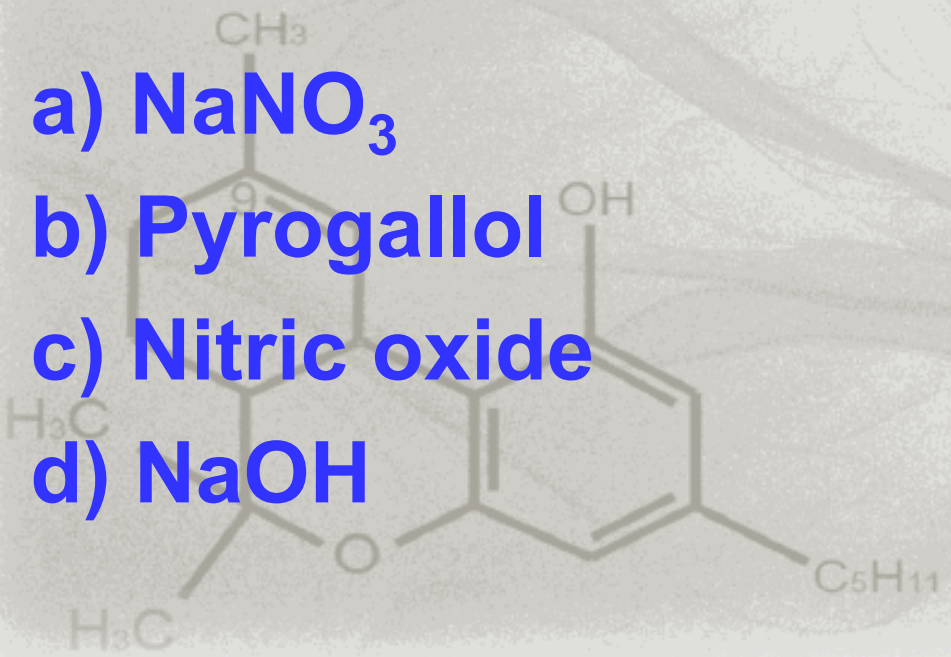
Q31. Which of the following is used in the isolation of noble gases from air by Ramsay Rayleigh method.

a) $NaNO_3$

b) Pyrogallol

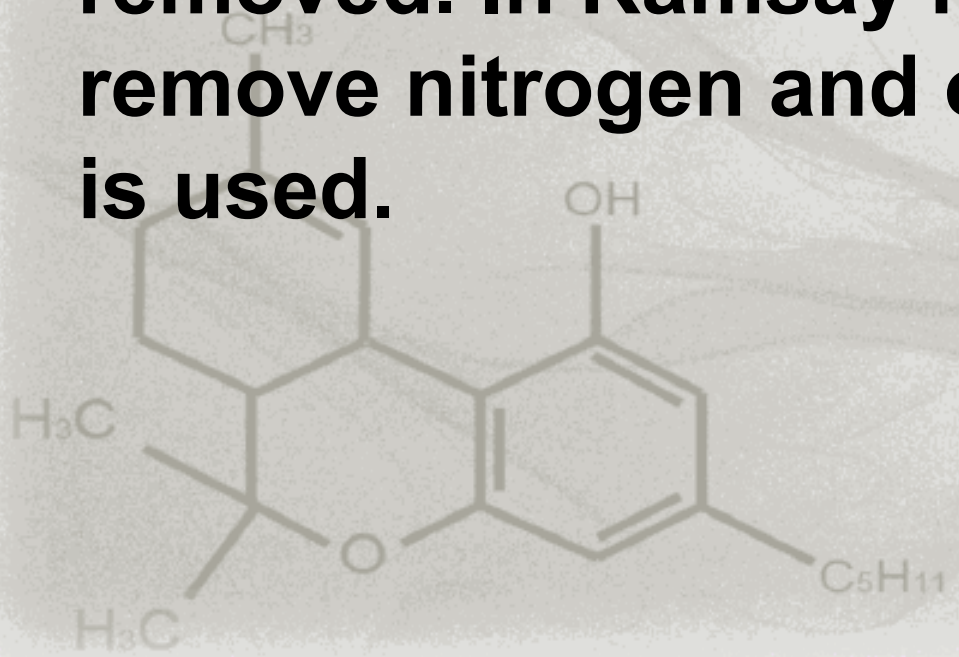
c) Nitric oxide

d) NaOH



Option d

To isolate noble gases from air, oxygen and nitrogen are to be removed. In Ramsay method to remove nitrogen and oxygen NaOH is used.



Q32. He-O_2 mixture is used by sea divers because

a) helium is much less soluble in blood than nitrogen

b) mixture is light

c) due to high pressure under the sea, nitrogen and oxygen would react

d) nitrogen in highly soluble in water

Option a

Under the sea, the pressure will be high. At this high pressure nitrogen dissolves in blood and once the diver comes out of the water the nitrogen absorbed will be released. The diver will feel pain and bends. To avoid this Helium is used which is less soluble compared to nitrogen.

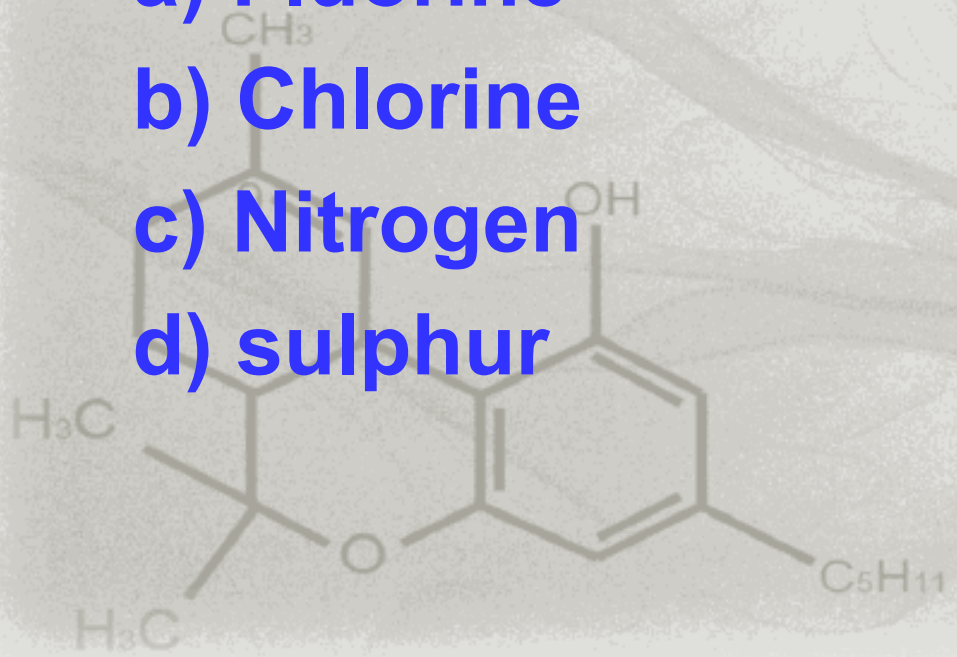
Q33. Noble gases form compounds mainly with

a) Fluorine

b) Chlorine

c) Nitrogen

d) sulphur



Option a

Xenon forms compounds with oxygen and flourine because of their small size and high electronegativity.

Krypton also forms compounds with fluorine but the ionisation energy of other noble gases is so high they are unreactive.

Q34. The most polarisable among the given noble gases is

a) Xenon

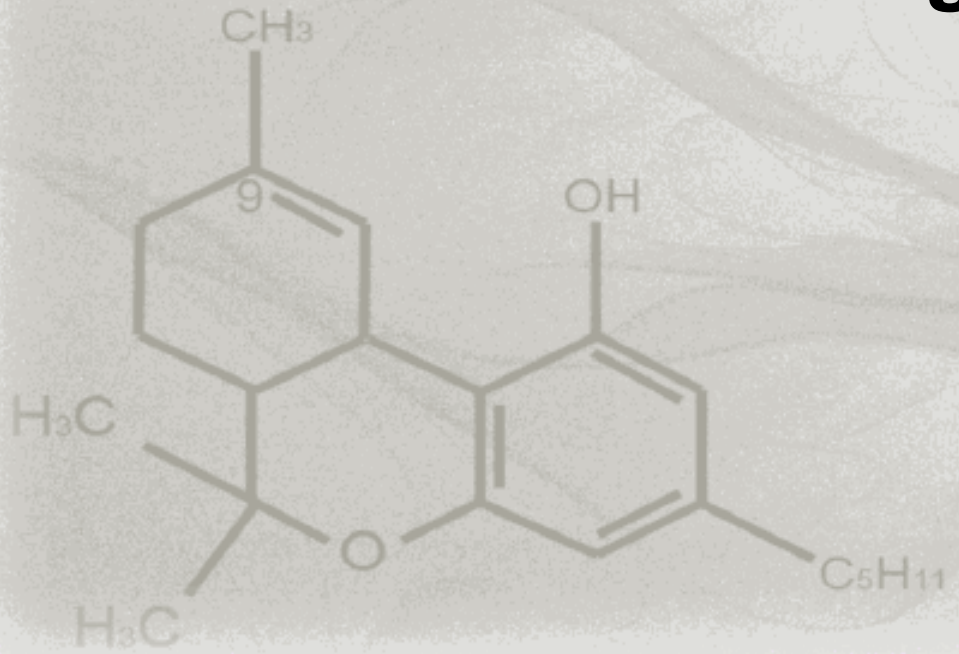
b) Helium

c) Neon

d) Argon

Option a

As size increases polarisability also increases. Hence, polarisability increases down the group



Q35. In contact process for the manufacture of H_2SO_4, the catalyst used and the liquid in which SO_3 is dissolved are respectively

a) Fe, H_2O

b) V_2O_5, H_2O

c) Pt, H_2O

d) V_2O_5, conc. H_2SO_4

Option d

The catalyst used in contact process for the manufacture of sulphuric acid is platinised asbestos or vanadium pentoxide (V_2O_5).

SO_3 formed is absorbed in conc H_2SO_4 to form oleum($H_2S_2O_7$) – fuming sulphuric acid which on dilution gives sulphuric acid.

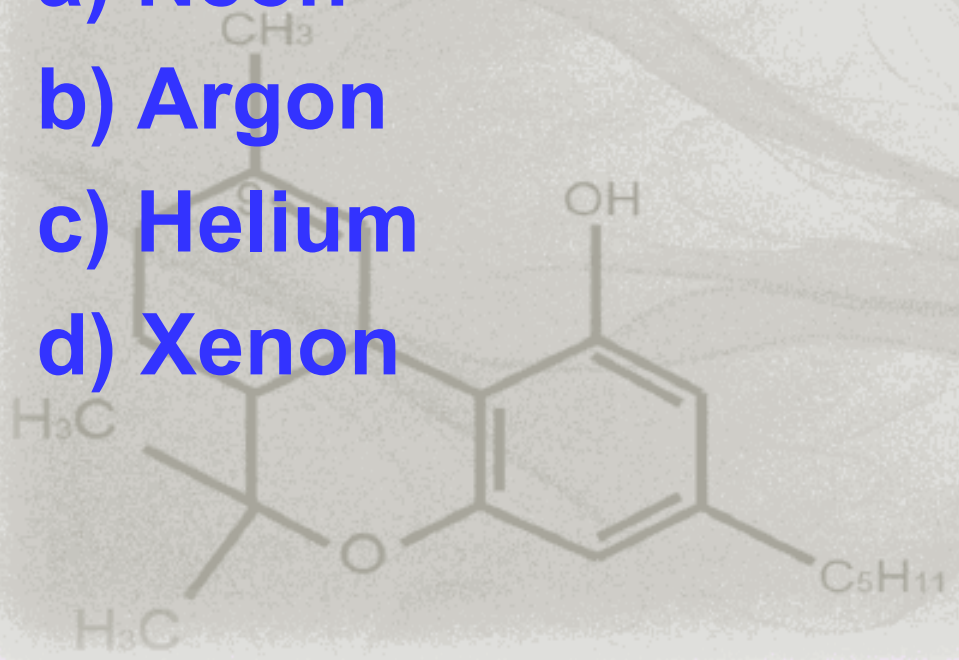
Q36. The noble gas which forms interstitial compounds is

a) Neon

b) Argon

c) Helium

d) Xenon



Option c

Interstitial compounds are those in which small atoms or molecules occupy the voids of the lattice of most of the heavy metals. Since helium is small in size and is comparable to the size of the voids it forms such compounds.

For the same reason He and Ne cannot form clathrates.

Note: Clathrates are non-stoichiometric compounds formed by trapping noble gases in cavities of crystal lattices of certain inorganic and organic compounds.

Q37.The red coloured discharge bulbs for sign boards mainly contain

a) Neon

b) Xenon

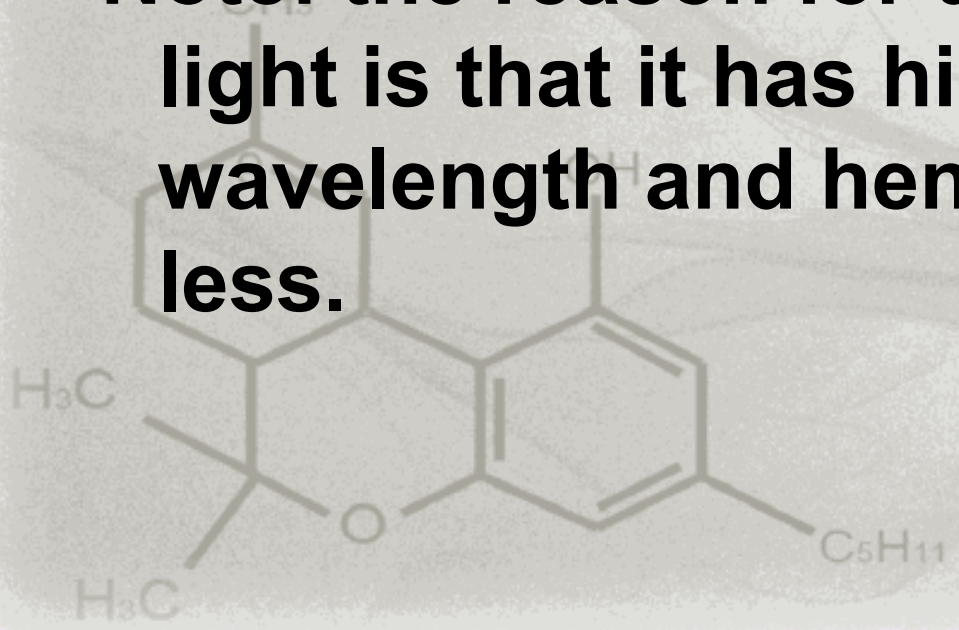
c) Radon

d) Krypton

Option a

In sign boards red light is used for which neon is used.

Note: the reason for using red light is that it has higher wavelength and hence scatters less.



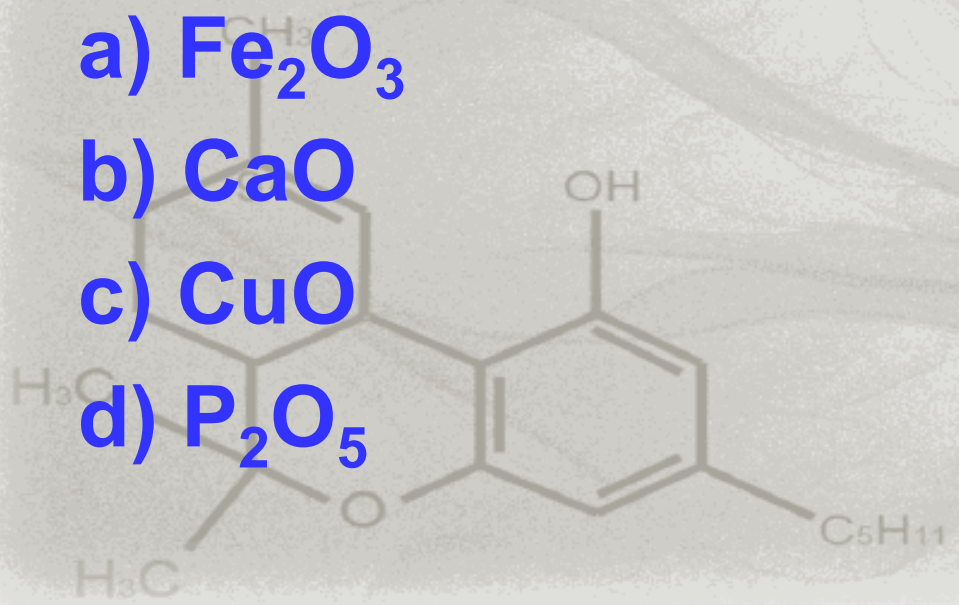
Q38. In the removal of silica during smelting of iron, the flux used is

a) Fe_2O_3

b) CaO

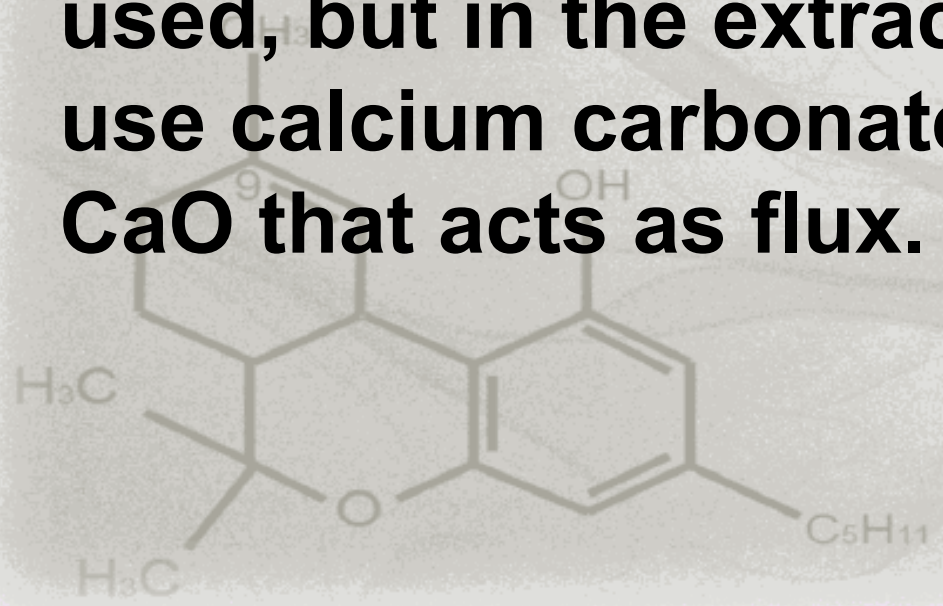
c) CuO

d) P_2O_5



Option b

Silica is an acidic gangue any basic gangue i.e any metal oxide could be used, but in the extraction of iron we use calcium carbonate which gives CaO that acts as flux.



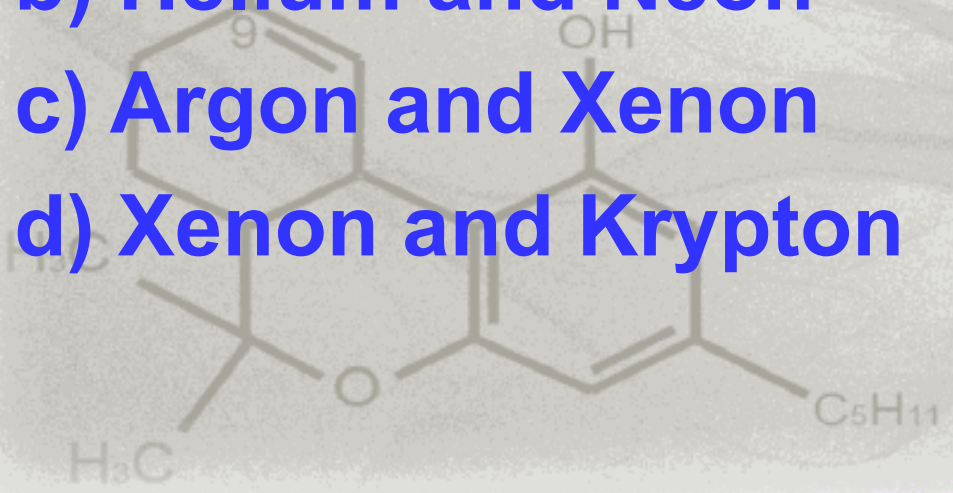
Q39. Coconut Charcoal kept at -(183K) is used to separate a mixture of

a) Neon and Argon

b) Helium and Neon

c) Argon and Xenon

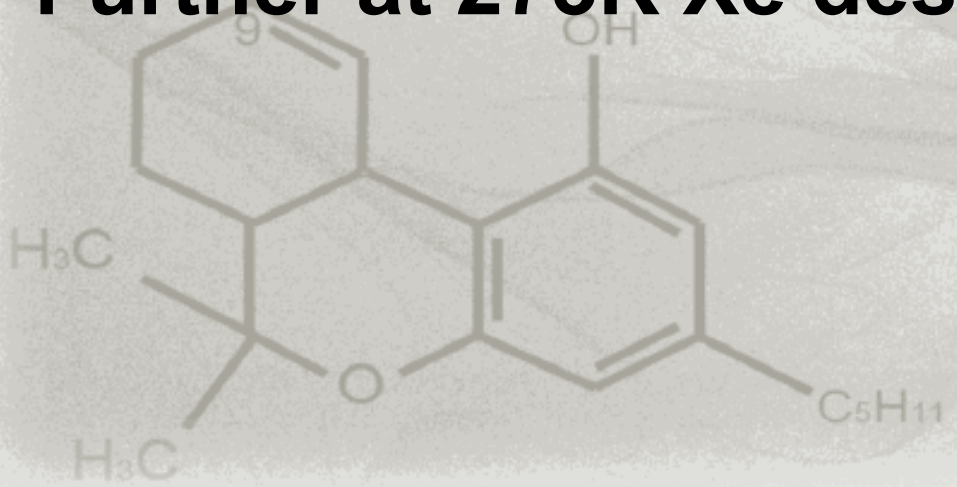
d) Xenon and Krypton



Option d

This is the last step of separation where krypton desorbs and Xenon remains in the charcoal.

Further at 273K Xe desorbs



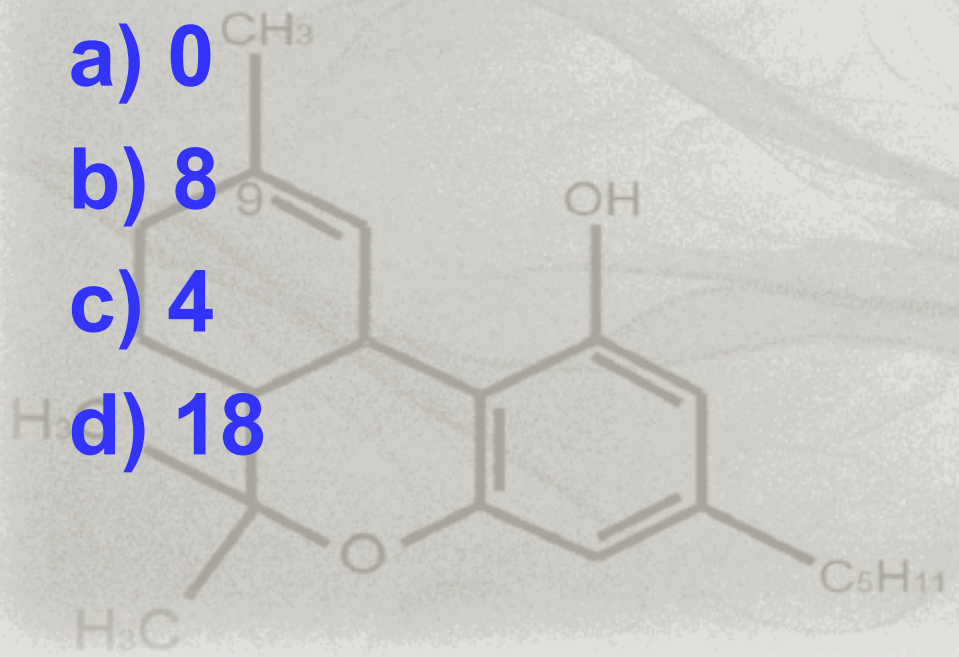
Q40. The number of unpaired electrons in a noble gas atom is

a) 0

b) 8

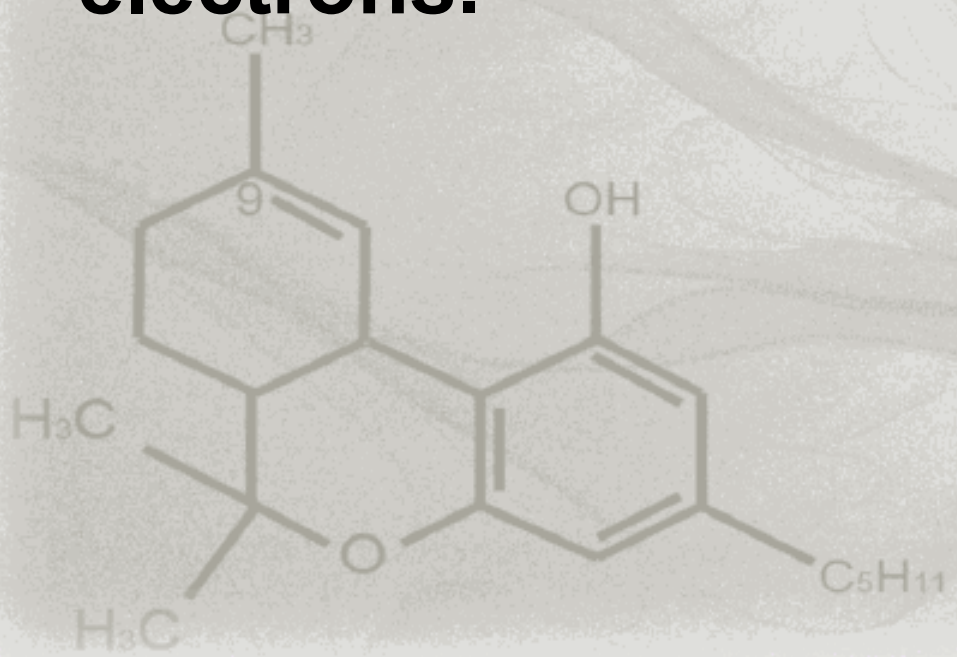
c) 4

d) 18



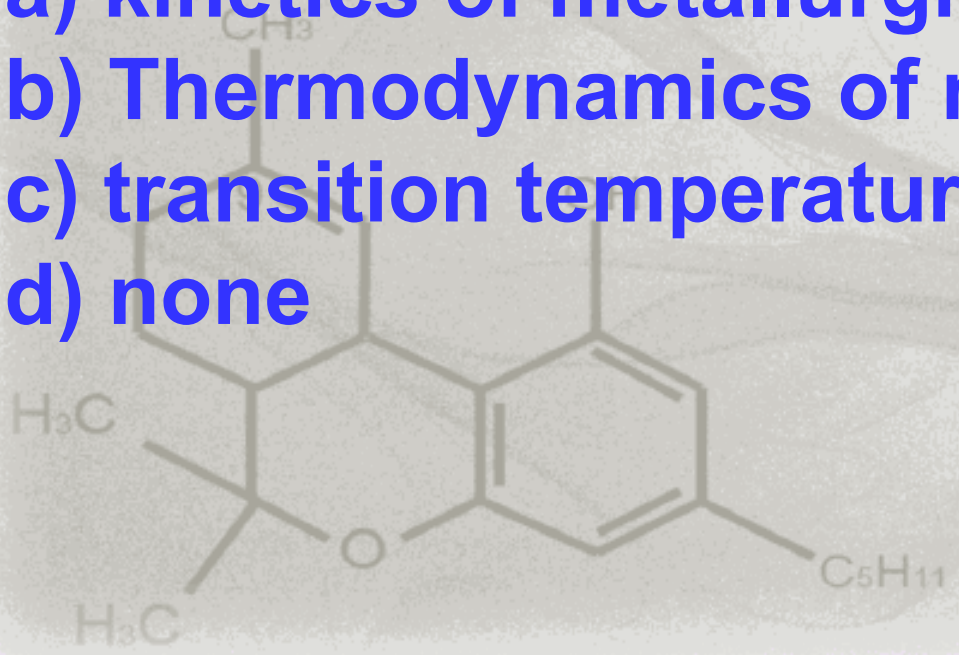
Option a

Noble gases have filled octet configuration, hence no unpaired electrons.



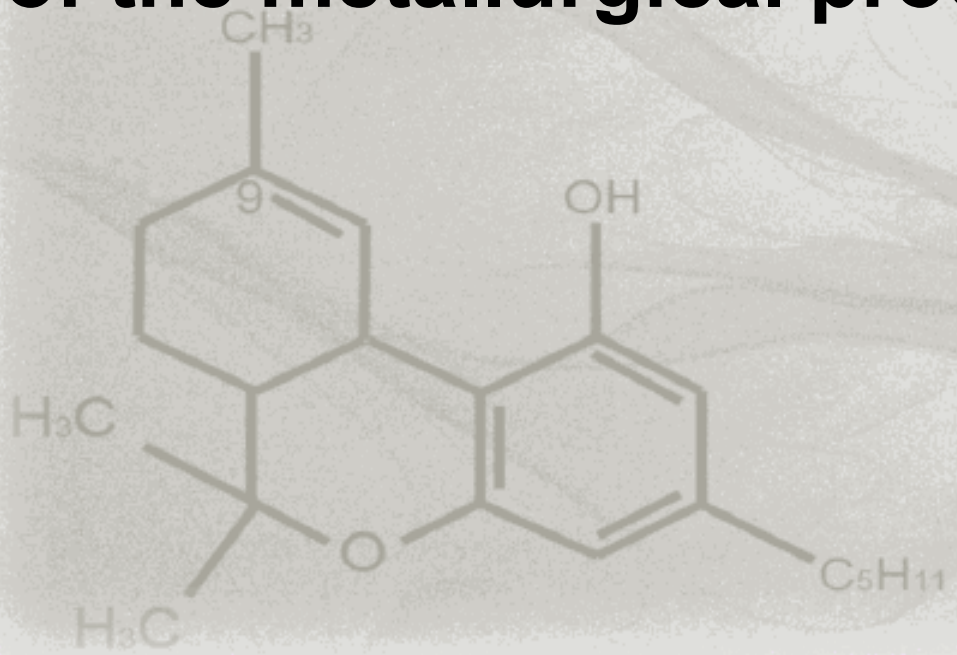
Q41.Ellingham diagram is used to explain

a) kinetics of metallurgical processes
b) Thermodynamics of metallurgy
c) transition temperature
d) none



Option b

Ellingham diagram gives us the thermodynamic aspect and feasibility of the metallurgical process.



Q42. The formation of $O_2^+[PtF_6]^-$ is the basis for the formation of Xenon fluorides because

a) O_2 and Xe have comparable sizes

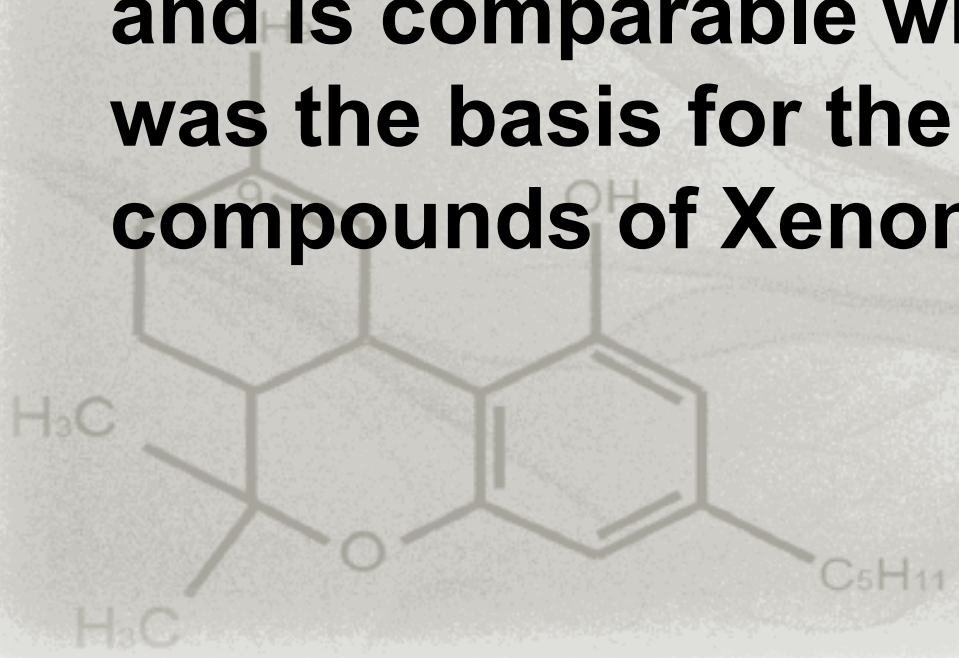
b) both O_2 and Xe are gases

c) O_2 and Xe have comparable ionization energies

d) O_2 and Xe have comparable electronegativities

Option c

Ionisation energy decreases down the group. Xe has lower ionisation energy and is comparable with oxygen. This was the basis for the formation of compounds of Xenon.



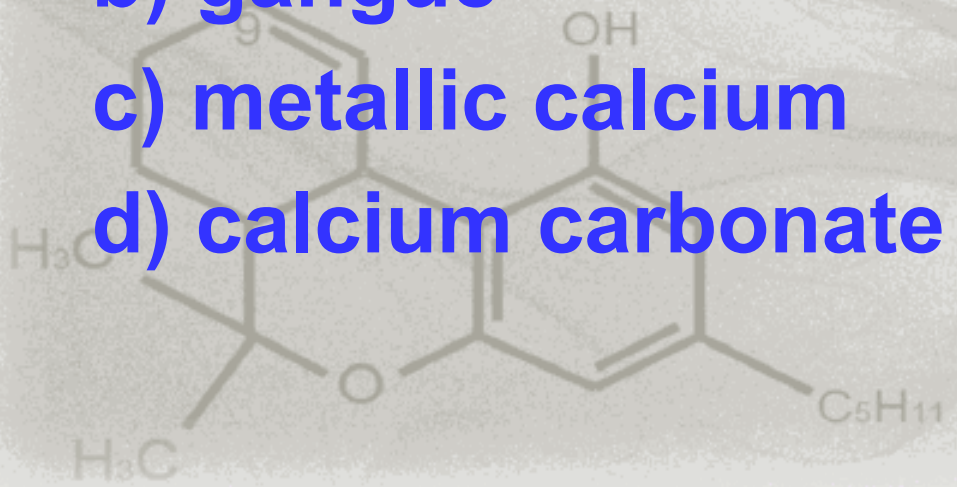
Q43. In metallurgy of iron, when $CaCO_3$ is added to the furnace, the calcium ion ends up in

a) calcium silicate

b) gangue

c) metallic calcium

d) calcium carbonate



Option a

In metallurgy of iron calcium carbonate is the flux. It decomposes to give CaO which actually removes silica as calcium silicate

$$CaO + SiO_2 \rightarrow CaSiO_3$$

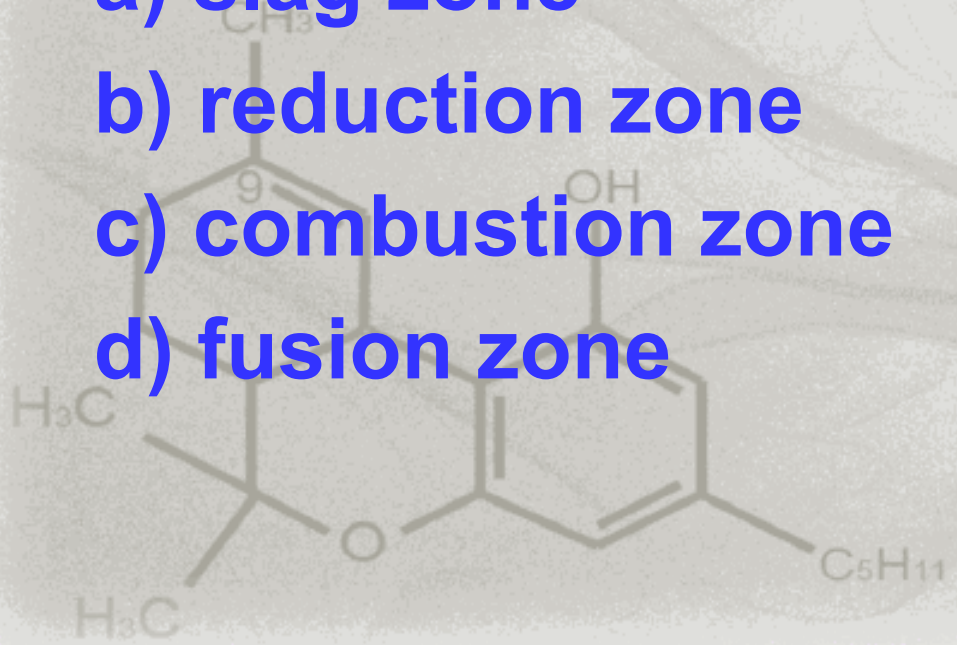
Q44. In the blast furnace maximum temperature is in

a) slag zone

b) reduction zone

c) combustion zone

d) fusion zone

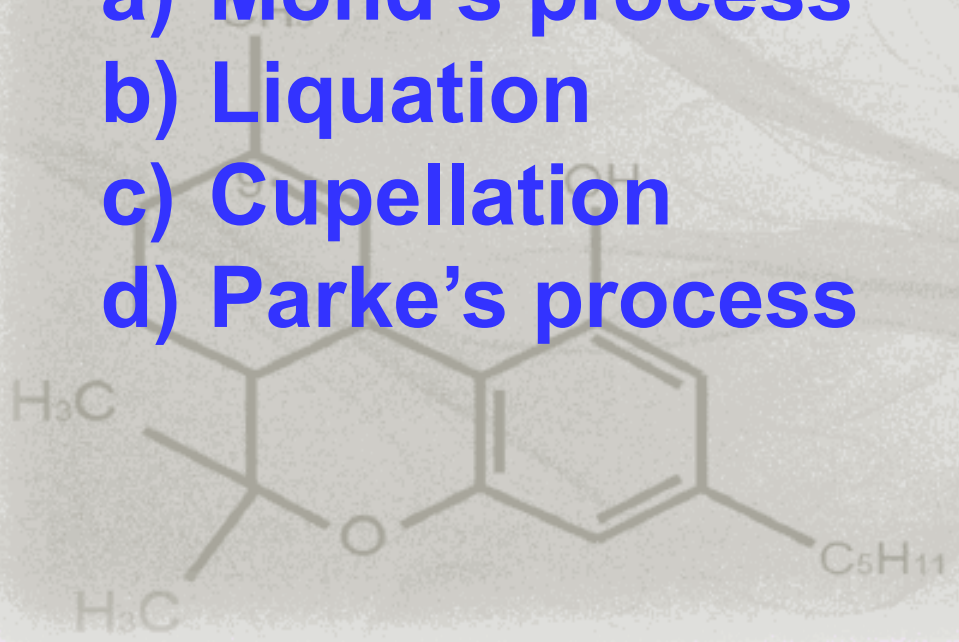


Option c

The temperature in the blast furnace is more at the bottom and gradually decreases and is very less at the top. Higher temperature is at the hearth of the furnace where combustion takes place. It is important to note different zones and their temperature range.

Q 45. Which of the following process is based on distribution law?

a) Mond's process
b) Liquation
c) Cupellation
d) Parke's process



Option d

Parke's process for desilverisation of lead is based on Nernst Distribution law.