2071- Bhadra

Set-1.

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1) Define buffer capacity and buffer range. Calculate the concentration of sodium benzoate that must be present in 0.1M benzoic acid to make a buffer solution of PH 3.7 (Ka for benzoic acid is 1.8×10^{-4})

→ Buffer Capacity :→ The buffer capacity is defined as the number of moles of acid or base added per litre of the buffer required to cause a unit change in PH.

$$\text{Buffer capacity} = \frac{\text{No. of moles of acid or base added per lit}}{\text{Change in PH}}$$

→ Buffer Range = THe PH range over which a buffer solution is effective is termed as buffer range.

For acidic buffer $PH = pK_a \pm 1$.

For basic buffer $POH = pK_b \pm 1$.

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3) Define heterogenous catalysis. Describe the Absorption theory of catalysis with suitable example. Write any two criteria for choosing catalyst for industrial purpose.

→ The catalysis in which catalyst is present in a different phase from the reacting substance is known as heterogenous catalysis.

e.g.:

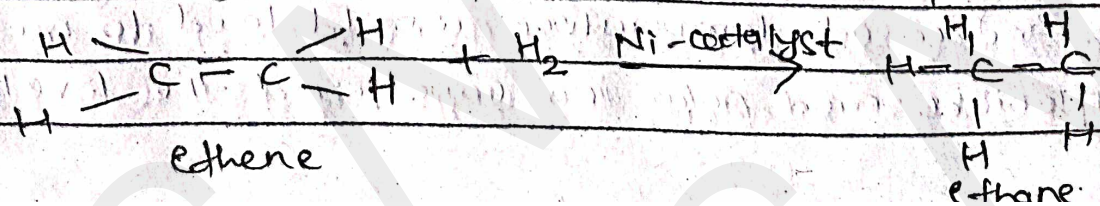
$$N_2(g) + 3H_2(g) \xrightarrow[500]{Fe(s)} 2NH_3(g)$$

Absorption theory:→ This theory has been developed to explain the mechanism of a reaction between two gases catalyzed by a solid catalyst i.e. heterogenous or contact catalysis. In this process, the reaction is initiated by adsorption of the reactant molecules on the surface of catalysts. The adsorption process results from the residual forces on the catalyst surface. It is considered that there is a continuous formation and decomposition of unstable intermediate which offer a new pathway involving a lower energy of activation for the formation of final products.

e.g.:

$$A(g) + B(g) \xrightarrow[\text{catalyst}]{\text{solid}} C(g) + D(g)$$

Hydrogenation of ethene in the presence of Nickel



ethene

ethane

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* Criteria for choosing a catalyst for Industrial Applicants

i) It should be cheap and easily available.

ii) It should be stable.

4) Global warming is one of the burning issues of the world. Point out major causes of global warming, its impact and also control measures.

→ Every year the world wide concentration of CO_2 is increasing by at the rate of 0.75 ppm and the temperature is rising at a rate 0.05°c per year. Other major gases causing green house effect or global warming or climate change are CH_4, NO, CFCs, O_3 and SO_2.

* Effects of Global warming.

i) Scientists estimate that the earth's average temp^r is increasing by 0.05°c per year.

ii) Changing regional climates could affects forests, crops, fields and water supplies.

iii) The increased temperature would lead to melting of glaciers and polar ice caps and the level of sea

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may rise there by flooding the coastal lands and change the climate radically.

* Measures of Global warming:

i) Reducing consomption of fossil fuel and such fuel and such as coal and petroleum.
ii) Recovering green house gases from the atmosphere
iii) Reduction in CFC production.
iv) Reforestation and conservation of forests so that plants can take up CO_2.
v) Development of environmentally compatible technologies.

5) What do you mean by water pollution? What are the major water pollutants, mention their adverse effects.

→ When toxic substance enter lakes streams, rivers, ocean and other water bodies they get dissolved or lie suspended in water. This results in the pollution of water where the quality of water deteriorates.

* Major causes:

- Domestic → The release of huge quantities of municipal and domestic wastes through drains into the rivers and canals is the major cause of pollution. The domestic waste water contains human faces, kitchen wastes, organic water that provides nutrition to bacteria and fungi

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- Non-point sources of water pollution:→ The water is also get polluted through agriculture discharge such as pesticide insecticide plant nutrients, fertilizers, etc.
- Surface run-off from Urban Areas:→ Effluents from urban areas containing substances like oils, greases, detergents, nutrients, heavy metals, e
- Biological oxygen Demand (BOD)
- Chemical Oxygen Demand (COD).

* Effects of water pollution

- The water borne diseases are typhoid and paratyphoid fevers, dysentry and chlorea polio and infectious liaepatitis.
- The use of pesticide helped in the eradication of diseases such as malaria and typhoid and also in boosting crop production.
- Destruction of Ecosystems: Ecosystems are extremel dynamic and respond to even small changes in the environment. Water pollution can cause an entire ecosystem to collapse if left unchecked.

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. Effects in food chain :→ Disruption in food chains happens when toxins and pollutants in the water are consumed by aquatic animals (fish, shellfish etc) which are then consumed by humans.

6) Explain preparation and uses of polyphosphazines and polymeric sulfur nitride.

→ Polyphosphazines can be prepared through a crystalline reaction between primary amines and triphosphoric acid. The general structure of a polyphosphazine can be represented as follows:

$(NP)_n$

where n represents the no. of repeating units and P represents a phosphorus atom. The structure of each repeating unit can be represented as:-

N=P-P=P-N.

Uses of Polyphosphazines

i) Energy storage: polyphosphazines have high energy density and can be used as electrode materials in rechargeable batteries and supercapacitors.

ii) Biomedical applications: Polyphosphazines have been investigated as drug delivery systems and as materials for tissue engineering.

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iii) Environmental applications :→ polyphosphazines have been studied as adsorbents for removing heavy metals and organic pollutants from water.

* Preparation of polymeric sulfur nitride.

→ Polymeric sulfur nitride (PSN) can be prepared through thermal decomposition of sulfonitrides or sulfur nitride precursors mixed with metal catalyst (Ni or Co). The mixture is heated at high temperatures (500-1000°C) in a nitrogen or argon atmosphere. The product is a mixture of PSN and metal sulfides, which can be purified by removing the metal sulfides. Careful control of reaction conditions is imp. for high yield and quality of PSN.

* Uses for polymeric sulfur nitride.

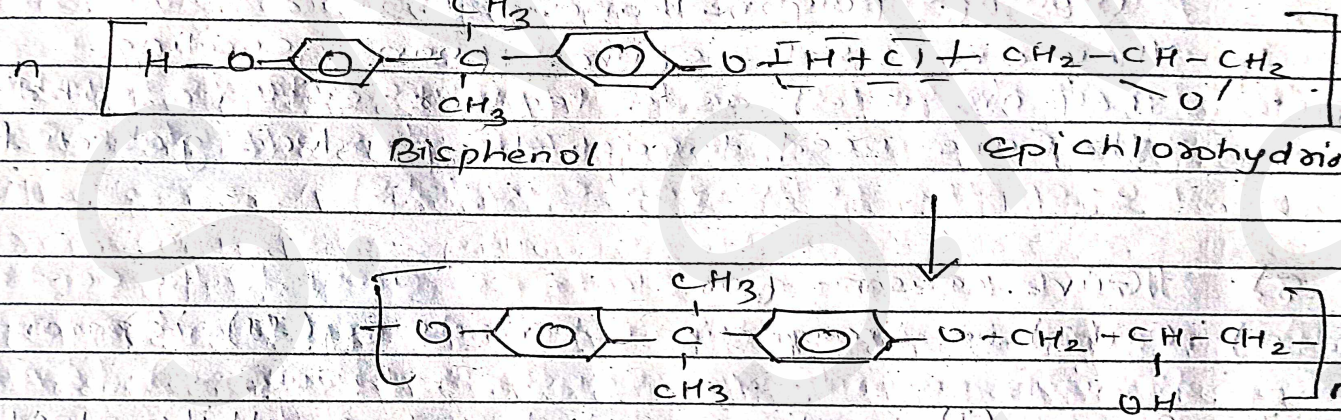
i) Memory devices for computers
ii) Ultrasonic delay lines, e.t.c.
iii) High energy particle detector multipliers.

7) What is biodegradable polymer? Mention preparation and uses of the following.

→ Biodegradable polymers are those which are decomposed in natural aerobic and anaerobic environments

a) Epoxy Resins Preparation

→ It is a condensation polymer obtained by the combination of bisphenol and epichlorohydrin. It is a three-dimensional cross-linked polymer. The value of n ranges from 1 to 20 and the molecular weight ranges from 350 to 8000.



Bisphenol Epichlorohydrin

Uses of Epoxy Resins:

i) For skid-Resistance surfaces for highway.
ii) As lamination materials used in electrical equipments.
iii) For the production of components of aircrafts and automobiles.

b) Polyurethane

→ Polyurethanes are prepared by the reacting of diisocyanate and diol. For example, perlon-U is prepared by the action of 1,4-butane idol with 1,6-hexenediisocyanate.

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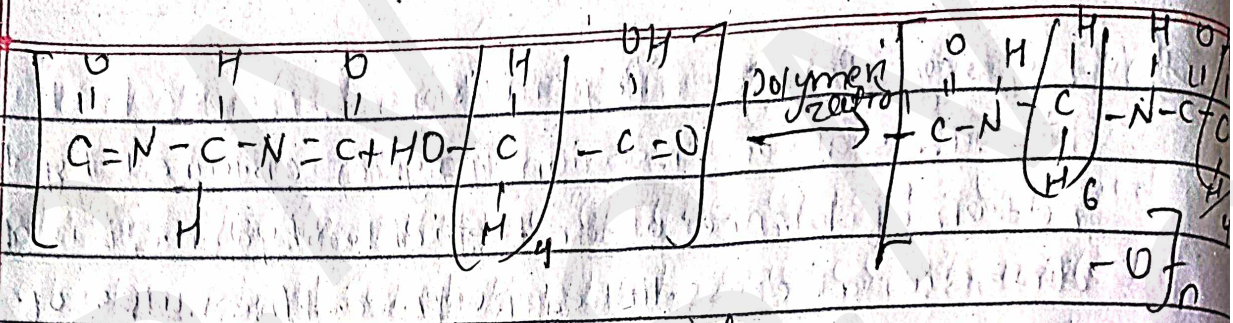

Hexamethylene diamine, adipic acid.

Uses of polyurethanes.

- They are used as films foams coatings.
- They are used as a leather ~~suitcase~~ substitute.
- They are used to cast to produce gaskets & seals.

8) Give reasons for

a) Cu(I) is dimagnetic where as Cu(II) is paramagnetic.

→ Copper(I) is dimagnetic because all its electrons are paired, resulting in a net magnetic moment of zero. In contrast, copper(II) is paramagnetic because it has unpaired electrons, leading to net magnetic moment. The paramagnetic behaviour of Cu(II) is due to the presence of unpaired electrons in its electron configuration, which result in the presence of a magnetic field and contribute to the net magnetic moment.

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b) TiO_2 is white and $TiCl_3$ is violet.

→ TiO_2 is white because due to its high refractive inde and ability to scatter light in all directions, resulting in a white appearance. $TiCl_3$ is violet because it has a partially filled d-orbital, which allows it to absorb certain wavelengths of lights, leading to violet color.

g) Give reasons.

a) The compounds formed by symbol 'V' element in +5 oxidation state are colourless but those formed in +3 oxidation state are colourful.

→ Compounds formed with "V" elements in the +5 oxidation state are colourless due to their electron configuration, which results in a neutral charge and a lack of interaction with light.

Compounds formed with "V" elements in the +3 state have partially filled d-orbitals, leading to unpaired electrons and the ability to absorb and re-emit light. This results in a colorful appearance. The presence of unpaired electrons in the +3 oxidation state results in a magnetic field, which contributes to the compound's color.

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b) Transition elements are mostly paramagnetic.

⇒ This is due to presence of one or more unpaired electrons in d subshell, which causes them to be attracted to a magnetic field. This gives them a positive magnetic moment and results in paramagnetism.

10) What do you mean by effective atomic number? Give IUPAC name and calculate the effective atomic no. of the following complexes.

→ The total no. of electrons around the central metal atom or ion donated by the ligands through co-ordinate bond is known as EAN.

a) $[Fe(CN)_6]^{3-}$

EAN of Fe^{-3}

$= (Z - x) + ny$

$= (26 - 3) + 6 \times 2$

$= 23 + 12$

$= 35$

The EAN of Fe^{3+} is not equal to the atomic no. of Kr (36).

Hence, it is unstable and paramagnetic.

No. of unpaired electrons = Atomic no. of Kr - EAN

$= 36 - 35$

$= 1$

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IUPAC Name of $[Fe(CN)_6]^{3-}$ is

→ Hexacyanoferrate (II).

b) $[Ag(NH_3)_4]^{+}$

EAN of $Ag^{+} = (z-x)+xy$

$= (47-1)+4\times2$

$= 46+8$

$= 54$

The EAN of Ag^{+} is equal to the atomic no. nearest inert gas.

i.e. Xe (=54).

∴ No. of unpaired electrons = At. No. of Xe − EAN

= 54 − 54 = 0

It contain, no unpaired electrons, hence it is stable and diamagnetic.

→ IUPAC name of $[Ag(NH_3)_4]^{+}$ is

→ Tetraammine silver(I)

c) $[Ni(CN)_4]^{2-}$

EAN of $Ni^{+2} = (28-2)+4\times2 = 26+8 = 34$

The EAN of Ni^{+2} is not equal to the inert gas Kr (=36).

∴ No. of unpaired electrons = At. No. of Kr − EAN

= 36 − 34 = 2

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It contains 2 unpaired electrons.

IUPAC name of $[Ni(CN)_4]^{2-}$

→ Nickel (II) tetracyanate.

d) $[Cr(CH_2O)_6]^{2+}$

→

ii) What are the inner orbitals and outer orbital complexes? Explain formation of $[Fe(CN)_6]^{4-}$ on the basis of valence bond theory and predict its magnetic behaviour.

→ Outer orbitals → The outer orbital complexes are formed due to sp^3d^2 hybridization in the central metal atom/ion. This type of hybridization takes place in the complexes which contain weak ligands.

→ Inner orbitals → are coordination compounds composed of a central metal atom having hybridization of the atomic orbitals including d orbitals of inner shell and s, p orbitals of the outer shell.

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$[Fe(CN)_6]^{4-}$

In the above coordination complex,

complex = $[Fe(CN)_6]^{4-}$

Let the oxidation state of Fe = x

$x + 6(-1) = -4$

$x = +2$

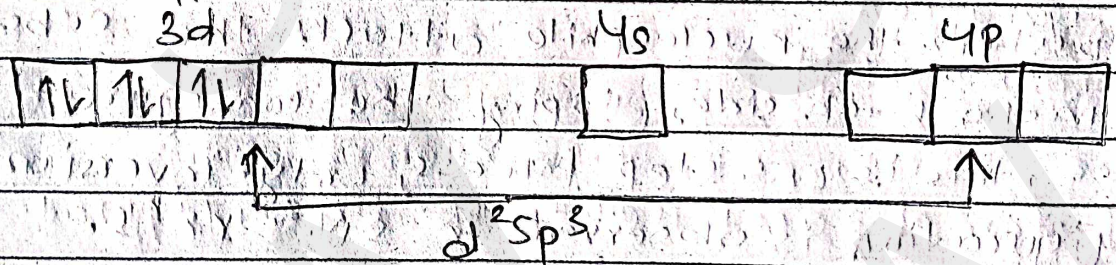
The electronic configuration of

Fe = $[Ar]\ 3d^6\ 4s^2$

The electronic configuration of

$Fe^{2+} = [Ar]\ 3d^6\ 4s^0$

CN^- is a strong field ligand. So, due to the presence of strong-field ligands, the pairing of 3d-electrons takes place.



Hybridization: d^2sp^3

Magnetic character: Diamagnetic

Spin: low spin complex

Hence, the geometry of the complex is octahedral and the complex is dimagnetic (as there are no unpaired electrons)

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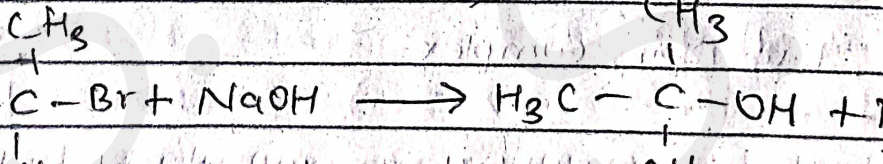
(12) Explain why SN^1 rxn gives both retension and invertion isomers but SN^2 gives only invertion isomer. Write the mechanism of given chemical rxn.

→ SN^1 rxn produce both retention and invertion isomers because they occur in two steps; first, the substrate's leaving group leaves, followed by attack by a nucleophile on the carbocation intermediate. This intermediate can form in two different stereochemical configurations, leading to both retention and inversion of configuration.

SN^2 rxn, on the other hand, occur in a single, concerted step where the nucleophile attacks the substrate from the back side, flipping the configuration. Since this is one step process, only inversion of configuration is observed in SN^2 rxns.

$$(CH_3)_3C-Br + NaOH \longrightarrow (CH_3)_3COH + NaBr$$



3° Tertiary alkalyl halide
2-methyl-2-Bromopropane

3° Tertiary alcohol
2-methyl-2-propanol

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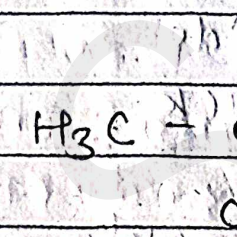
Mechanism.

Nucleophile cannot attacke substrate carbon directly because the substrate carbon is more crowded.

i-e.

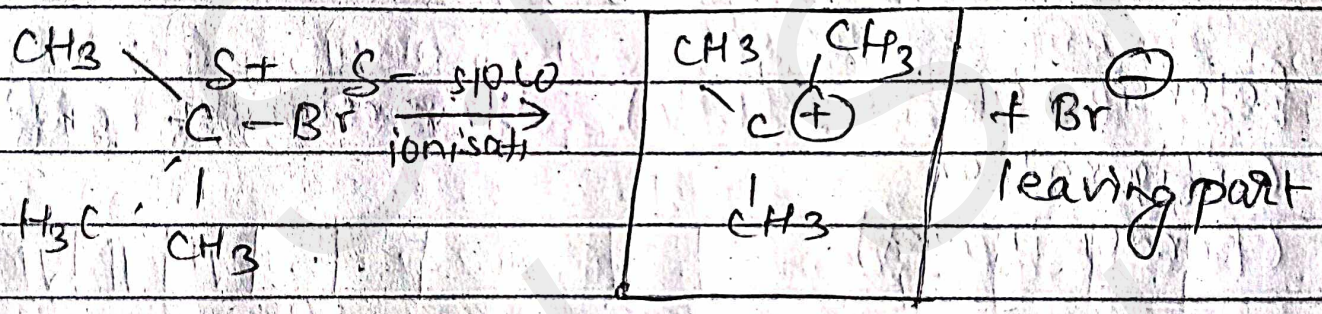


Hence, the rxn consists of two steps.

Step I:-

It takes place by the ionization of tertiary alkyl halide into carbonium ion and leaving part.

i.e.



Tertiary butyl Carbonium ion

The step (1) is slower and determines the rate of rxn. Hence, it is known as rate determining step.

Step-II.

The step two involves the first attack of the nucleophile on the carbonium ion. It may attack from front side and backside to give tertiary alcohols i.e.

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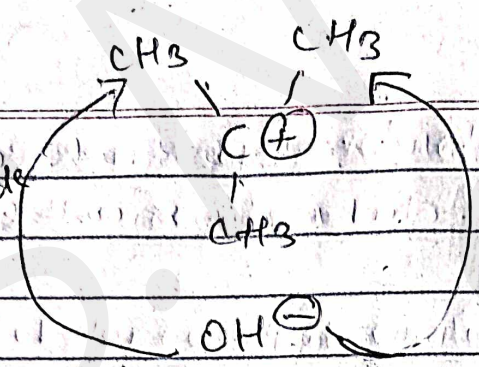

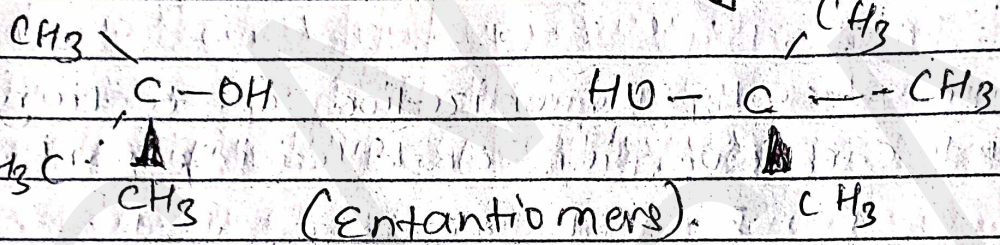

(Enantiomers).

Retension of configuration (perdominates)

Inversion of configuration

Eg. - Partial racemisation of SN1 configuration

As a result, the product obtained is expected to be racemic containing equal no. of molecules with retension and inversion configuration.

(13) Distinguish between enantiomers and diasteriomers. Show these isomers in 3-bromo-2-butanol.

→ Differences are:

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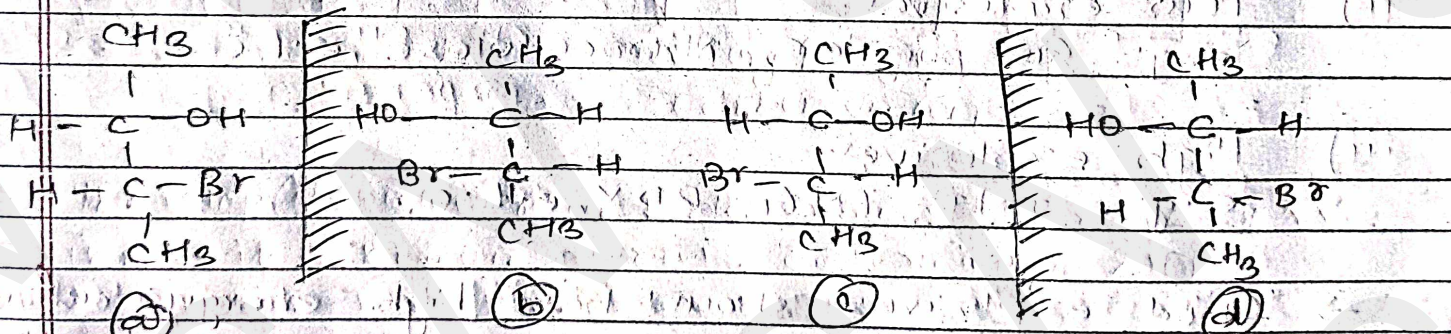
Enantiomers	Diasteriomers
• Non-super impasable image isomers are Enantiomers.	• are not the mirror imag of each other.
• They have same physical properties.	• have similar chemical properties.
• They have identical chemical properties except towards optically active reagent.	• They have different physi properties like: melting point, Boiling point, etc.
• They cannot be separated by physical technique.	• can be separated by technique like fractional crystalization, distillation,



3, -bromo, 2-butanol

Enantiomers => ab and cd

Diastereomers => ac, bd, ad and bc

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(4) What is an explosive? classify explosives with examples. What is the requirement of good explosives?

→ is a substance that contains a great amount of stored energy that can produce and explosion, a sudden expansion of the material after initiation, usually accompanied by the production of light, heat, sound and pressure.

Classification of explosives

i) Primary explosives
e.g. Leadazide (PbN_6), silver azide AgN_3.

ii) Low explosives
e.g. Gunpowder, Nitrocellolose, etc.

iii) High explosives
e.g. TNT, TNG, RDX, etc.

→ Good explosives should have high energy release, stability under storage conditions, ease of handling, and specificity in activation. Additionally, they should not be too sensitive to heat, friction or shock and should not produce toxic or dangerous by-product upon detonation.

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15) What are elimination reactions? What are the differences between E1 and E2 rxn mechanisms taking suitable example.

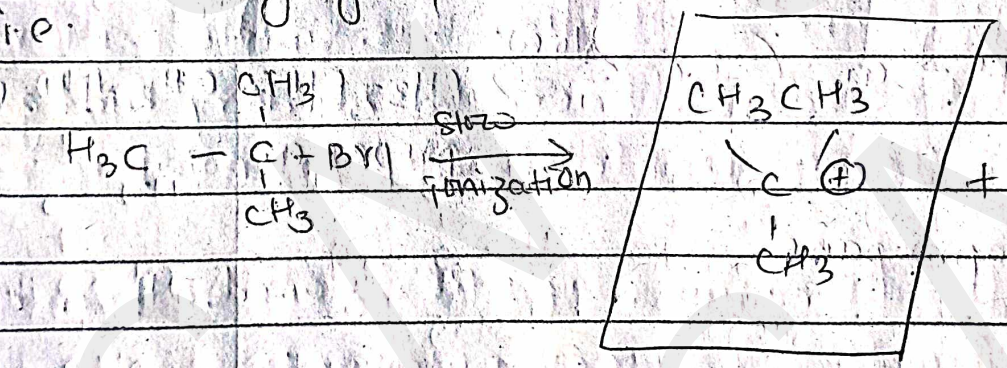
→ The rxn in which atoms or groups from two adjacent carbon atoms in the substrate molecule are removed and multiple bond is formed, it is known as elimination rxn.

E1 rxn mechanism

→ It involves two steps.

1) The first step involves the slow ionization the alkyl halide to give the carbonium ion and leaving group.

i.e.



3° carbonium ion

It is slower steps so it is called rate determining step because it determines the rate of rxn.

Step II: It involves the fast abstraction of a proton by the base from the adjacent β-carbon atom leading to the formation of an alkene.

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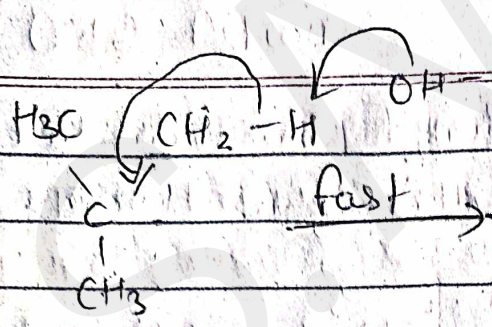
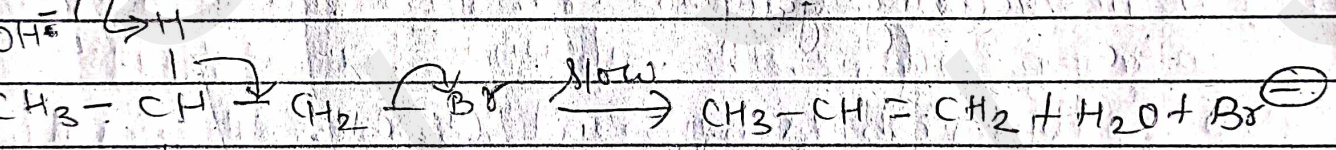


2-methyl propene

* E2 rxn mechanism.

- One step in which the abstraction of proton from the β-carbon by base i.e. OH^- ion from alcoholic, KOH and the repulsion of the leaving group ie. halide ion from the α-carbon atom occur simultaneously, It can be represented as follows;



1 Bromopropane

In these rxns, the H and groups to be eliminated i.e. H atom and Br are trans to each other. Hence, it is known as trans elimination rxn.

16a) What is lubricant? Write about the application of different types of lubricants.

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→ Any substance introduced between two moving/sliding surfaces with a view to reduce the frictional resistance between them is known as lubricant.

Application of lubricants

- Reduces waste of energy, so machine efficiency is enhanced.
- It reduces expansion of metal by local frictional heat
- Acts as a coolant.
- Reduces the maintenance and running cost of machine

16b) Write the characteristics of good paint.

→ They are -

- It should possess high covering power.
- It's film should be stable.
- Should form a quite tough, uniform, adherent and impervious film.
- Film should not get cracked on drying.
- Film should be glossy (i.e. having shine and luster)
- Should posses high adhesion capacity to the material over which it is intended to be used.