Dr. Fadare's Part

CHM 405

Pharmaceutical Industry: They deal with pharmaceutics

Pharmaceutics

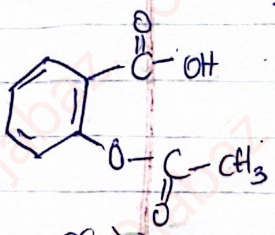
(i) Drug molecules (API) → Active Pharmaceutical Ingredient

(ii) Excipients: The most important excipient for tablet is Starch. The starch functions as a binder for the drug molecule, it make the drug hard.

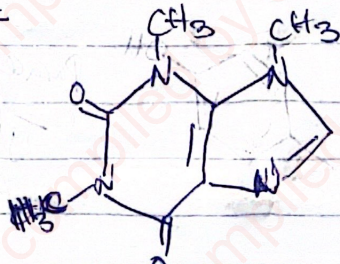
Anything to be used in the pharmaceutical industry must be 99.9% pure, very pure.

The Starch used in the pharmaceutical industry is corn starch

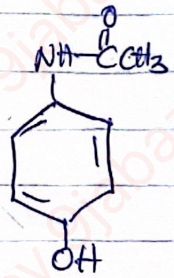
API



aspirin



Caffeine



Paracetamol molecule

Amin C – Ascorbic acid

Polypropylene is resistant to chemical attacks.

Solutions (drip)
(i) intravenous
(ii) Saline, ionic
(iii) therapeutics

fat soluble

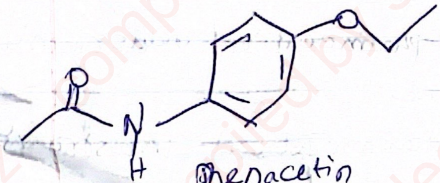
(4) Injection (5) Emulsion (6) Stabilizers e.g Tocopherol, ascorbic acid

(7) Vaccines (8) Antibodies

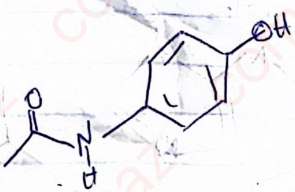
↓ water soluble

Assignment

Get more list of Pharmaceuticals.



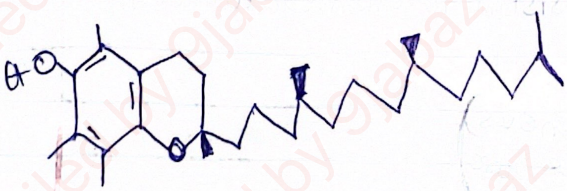
Phenacetin



Paracetamol

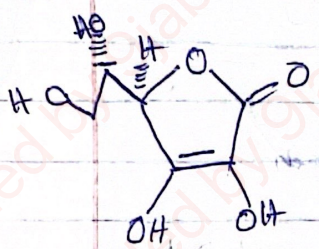
Tylenol

Tocopherol structure



*It can behave like an anti oxidant

- antioxidant helps to preserve the shelf life of a molecule



ascorbic acid

$R^{\cdot} + H \longrightarrow RH$

$RO^{\cdot} + H \longrightarrow ROH$

Chemist do;
(i) Organic synthesis
(ii) process chemistry
(iii) Chemical engg
(iv) Industrial chemistry

Difference between API Vs Tablet

- paracetamol API is the drug molecule
  paracetamol tablet is the drug molecule + excipients + stabilizers

Chemistry do
Analysis (i) Purity level (ii) Quality control

API

(1) Non Steroidal Anti inflammatory agents (NSAIDs)
(2) Antimicrobial agents
(3) Antimalarials
(4) Anti depressants

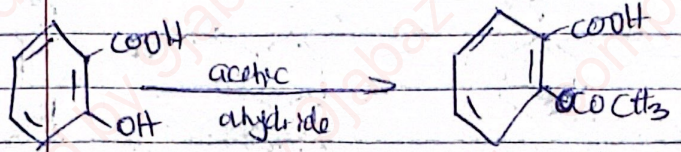
* Research & Development (R&D) : Drug Design and Development

- Organic Synthesis
- Pharmacology
- Biochemistry
- Microbiology

NSAIDs

(i) Aspirin
(ii) Paracetamol
(iii) Ibuprofen
(iv) Naproxen
(v) Diclofenac
(vi) Indomethacin

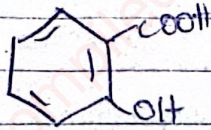
Aspirin Preparation



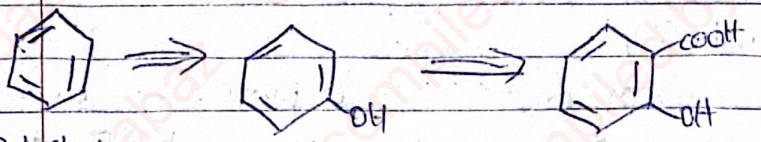
Salicylic acid

Acetyl salicylic acid (Aspirin)

Starting Material



① Salicylic acid. What is the source??



Petrochemical

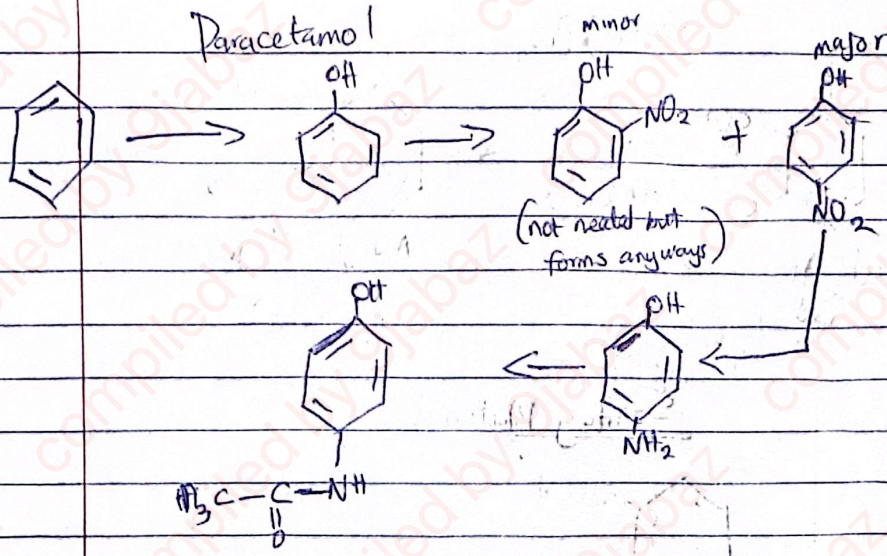
petro chemical

② Determine if it will be economical to produce salicylic acid through petro chemical (natural or synthetic means)

① Condition

② Chemical reaction

③ Equipment



Para acetaminophenol

(a) What is the industrial production of paracetamol, write all steps.

(*) In the industry, describe all the process and conditions (A) for the production of paracetamol API

* Dumas process

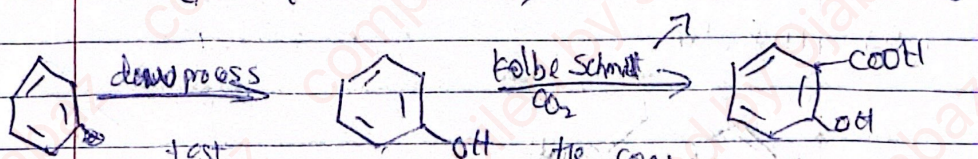
13/11/2025

tea → conc → column chromatography → isolated white powder → melting point → UV → mass Spectroscopy → elemental analysis → formular

NMR → Structure

Synthesis

The pharmaceutical company is a petrol halide industry. Salicyclic acid can be gotten starting with benzene (from petrochemicals)



* Explain dumas process and how to get the conditions to get a good yield.

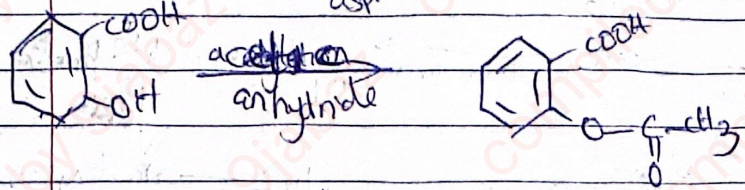
Condition

(i) catalyst (ii) temperature (iii) pressure (iv) solvent

If the temperature is 105° – 150°C it favours the ortho product but if the temperature is 220° – 250°C it produces the para product

Side Effect started showing up e.g ulcer due to the phenolic OH, then it was esterified by acetylation

* Salicyclic acid is the precursor to aspirin.

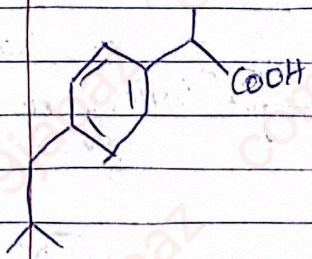


Meanwhile, aspirin still causes ulcer but not as much as salicyclic acid. Therefore other drugs have been made to resemble ~~aspirin~~ Salicylic. eg Paracetamol.

(i) 

It has been made to have the therapitic feature of salicyclic acid and not cause ulcer, which has been successful.

(ii) Ibuprofen



Precursor molecule is the one that we can do a slight modification to get our target molecule

Precursor ⟶ Target molecule
↓ breakdown in biological system
Metabolite

Industrial Processes for making API

(1) The reaction(s): Feasibility (consideration) is considered
(2) Reagents : Source, affordability is considered
(3) Condition : affordability, infrastructure is considered.

Assignment & test

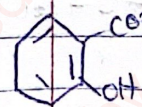
Types of reactors in industry.

test
What are the considerations?

(4) Work-up
(i) filtration
(ii) recrystallization
(iii) Purification (chromatography) => Find out what type of chromatography
test.
(iv) Analysis ⟶ What do you consider in analysis??

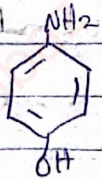
14/11/25

Aspirin



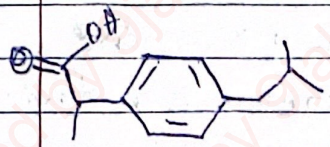
Precursor molecule

Paracetamol



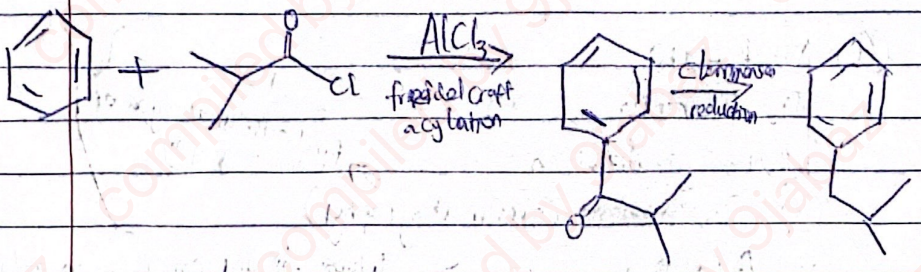
Precursor molecule

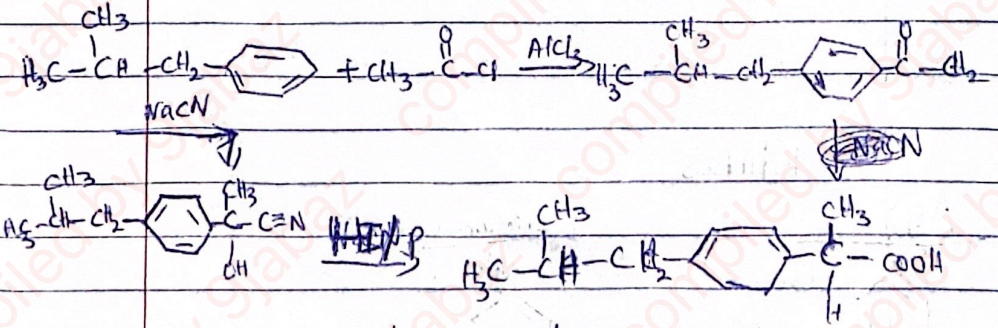
Ibuprofen



Ibuprofen

We can start with benzene





* Why grignard reagent not used?

Atom economy is a measure of ~~mass~~ efficiency of a chemical reaction, specifically the proportion of reactant atoms that are incorporated into the desired products

Boots synthesis step; it is 40% atom efficient

(1) Friedel acylation of isobutyl benzene with acetyl chloride
(2) Darzens reaction with ethyl chloroacetate to form epoxy ester
(3) Hydrolysis and decarboxylation to form an aldhyde
(4) Condensation with hydroxyamine to form an aldoxime
(5) Dehydration of the aldoxime using acetic anhydride to yield to nitrile
(6) Acid-catalyzed hydrolysis of the nitrile to the final carboxylic acid (ibuprofen)

* White is not a colour, all colours originates from white

Dr. Tawil's Part

CHM 405

1. Dyes and pigments
2. Steel Industry
3. Soap and detergents
4. Textiles

Chemistry of Dyes and Pigments

Dyes and pigments are important classes of coloured compounds used extensively in textiles, paper, in food, plastics, cosmetics, and art industry, also in automobiles

Both dyes and pigments are substances that impact colour, but they differ mainly in their solubility and the way they interact with the substrate

Differences Between Dyes and Pigment

Feature	Dye	Pigment
(1) Solubility	Dyes are soluble in water or suitable solvent (water soluble)	They are insoluble in water or organic solvents (water-insoluble) They are soluble in inorganic solvents
Application	Dyes penetrates and chemically bonds with fibers	The adher or stick to surface with dispersion or binders

Feature	Dyes	Pigment
(E) Bonding Mechanism	Chemical affinity between the dyes and the substrate (Ionic, Covalent, hydrogen bonding; van der Waal).	It is purely physical adhesion e.g.
(F) Examples	Methylene Blue, Congo red, Alizarin, Methyl orange	Titanium dioxide, Prussian blue

(G) Origin and Historical Background

The use of dyes and pigments dates back thousands of years. Natural dyes are derived from plants, animals and minerals

Examples

(i) Indigo is obtained from Indigofera tinctoria (Blue dye)
(ii) Alizarine from Madder root. Rubia tinctorium,
(iii) Cochineal from carminic acid extracted from insect
(iv) Tyrian purple Obtained from mollusc (most expensive)
6, 6'-dibromoindigo

Synthetic Dye

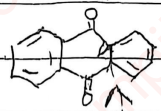
Synthetic dye began with William Henry Perkin's accidental discovery of Mauveine in 1856 from Aniline. This discovery marked the birth of the Synthetic dye industry

Azo dyes are nitrogen containing dyes
* structure

and modern Organic Chemistry.

Classification of Dyes

Dyes can be classified by Chemical Structure or by their application



Class of dyes	Example	Functional groups / Chromophore
~~Azo dye~~	~~Methyl Orange, congo red~~	
(i) Azo dye	Methyl orange, congo red	$-N=N-$
(ii) Anthraquinone dyes	Alizarin,	Anthraquinone nucleus
(iii) Triphenylmethane dyes	Crystal violet	The central carbon linked to three phenyl ring 
(iv) Nitro and Nitraso dyes (difference??)	~~Picric~~ acid Picric acid	$-NO_2$, $-NO$ (are used to form metal complexes more readily)
(v) Phthalocyanine dy (Phthalocyanine)	Phthalocyanine blue	A large macrocyclic system with metal ion

Classification by Application

(1) Acid dyes: used for wools, silk. Example of such as orange II

(2) Basic dyes: used to dye acrylic materials. Example is methylene blue

(3) Direct dyes: Applied directly to cotton. Example; congo red

(4) Vat dyes: These are insoble dyes reduced to soluble form (application) during dye. ~~Vat dye as~~ Example is indigo

(5) Dispersed dyes: These are used for hydrophobic fibres

Chemical properties of Dyes and Pigments

(1) Chromophore: Bunch of functional groups that gives colours to substances. The colour of the dye is due to (functional groups) certain groups, containing multiple bonds known as chromophores.

Examples; NO_2, NO, -CO-, -C=C-, -C≡C-, C nitro, nitroso, carbonyl

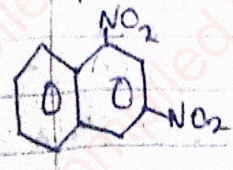
As the number of chromophore increases for a dye, the colour of the dye ~~also decreases~~ deepens

(2) Auxochromes: They are not chromophores in the sense that they don't give colour, but their presences increases the intensity of the colour, it deepens the dye. They are groups that modify the solubility and the intensity of the colour.

(2) Auxochromes:

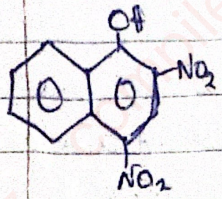
Examples, $-CH_3$, $-NH_2$, NHR, NR, (Cl, Br, I), $-SO_3H$, $-COOH$

For example, 1, 3, dinitronaphthalene



Pale yellow

But when Auxochrome is present, e.g OH



(2, 4, dinitronaphthol)

yellow → orange red.

The colour becomes, orange red.

Resonance and Conjugation

Extended π-conjugation lowers the energy gap between the HOMO and LUMO. This results in the shifting of absorption into the visible region

Acid-Base properties

- pH can change dye colour due to structural resonance e.g phenolphthalein

Valence is the number of bond surrounding an atom
* valency is the combining power

(1) Valence Bond Theory

In the ground state, the electron pair of a molecule are in a state of oscillation, not Vibration and absorb a photon of appropriate energy and gets excited when placed in the path of a beam of light.

The wavelength of the photon of light absorbs depends upon the energy difference between the ground state and the excited state.

Molecular orbital Theory

According to molecular orbital Theory, whenever a molecule absorbs a photon of light, one electron is transferred from bonding (non bonding orbital) to an antibonding molecular orbital. Based on different type of electrons present in a molecule, different types of electron transition are possible.

Synthesis of Dyes

(1.) Azo dyes: These dyes constitute the largest part of the synthetic dyes. The chromophore of the Azo dye is an aromatic system joined with the azo group and the presence of an auxochrome

$NaNO_2$ / HCl

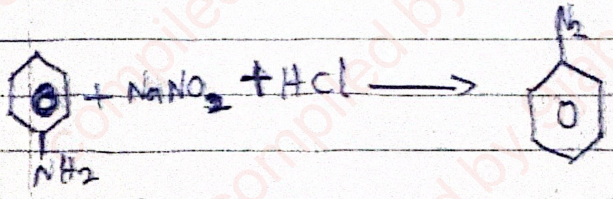
Reaction of p-dimethylaminoaniline

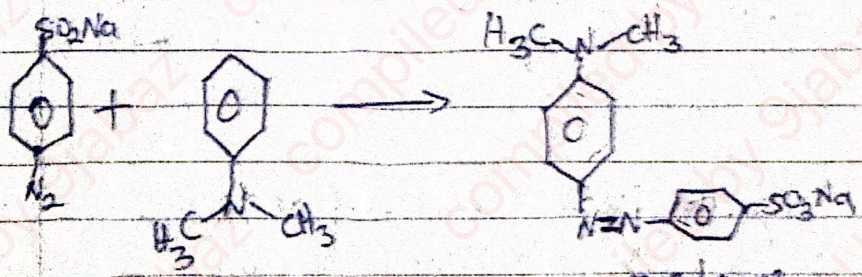
Azo dyes are classified according to the number of azo groups in the molecule. We can have a monoazo dyes, diazodyes, triazodyes.

Examples: Methyl orange, an example of monoazo dyes

1st step: Methyl orange is synthesized / obtained by converting aniline into a diazonium salt (diazotization)

2nd step: Coupling reaction: The diazonium salt reacts with another aniline in an alkaline medium





methyl orange.

Preparation of Methyl Orange

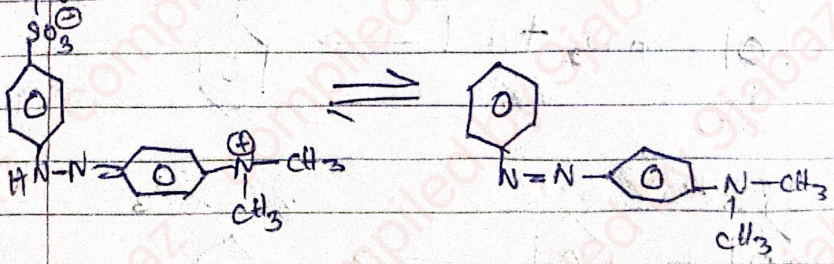
Methyl orange is a coloring dye for wool and silk, but its colour fades on the exposure to light and washing, usually it is not used as dye, but used as an indicator in the

acid base titration

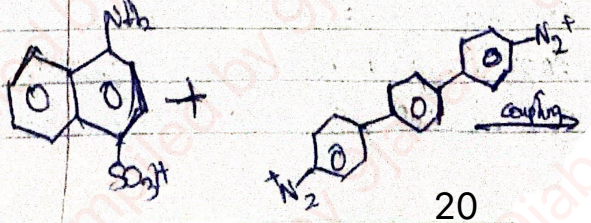
The pH range of methyl orange is between 3.1–4.4

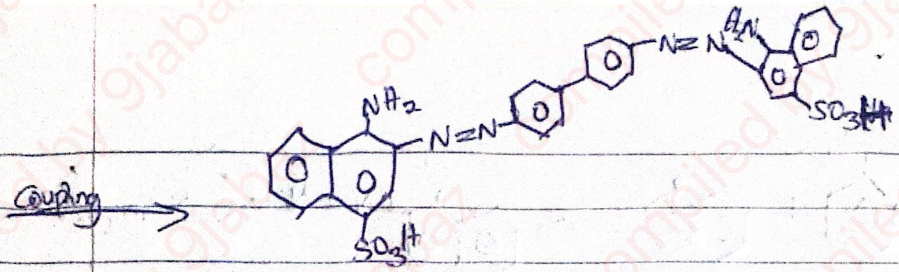
It is yellow in basic solution and red in acidic solution

The colour change takes place because of the change in the colour of ions ~~because~~ in basic and acid medium. In acidic medium, the ion contains P-quino / while in basic medium it contains azo chromophore



Congo red: It is an example of diazo dye. It contains two azo groups. It is Prepared by coupling of tetrazotized Benzidine with two molecules naphthonic acid (4-aminonaphthalene-1-sulfonic acid)





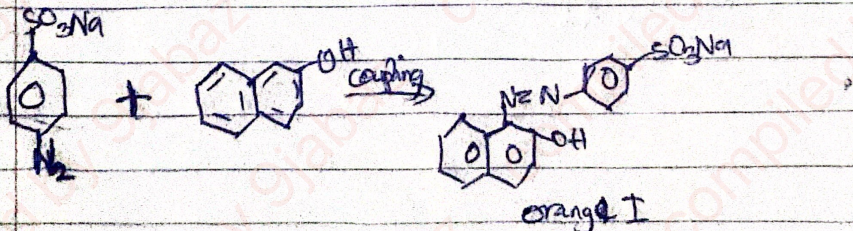
It is a direct dye and sodium salt of this dye gives red colour on the application to cotton

On addition of acid, its colour changes, because of this, it is not used as dye generally, mostly, it is used as an indicator. It is blue in acidic solution and red in solution above pH of 3

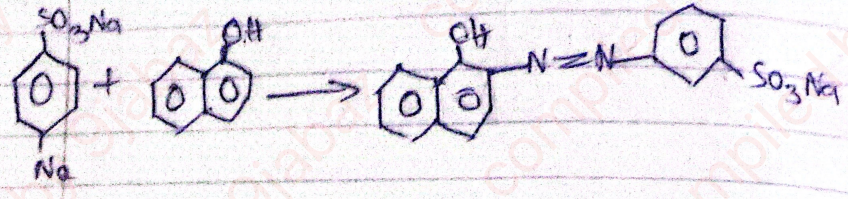
The change in colour from red to blue in acidic solution is due to the resonance among the charged canonical structure

Orange I:

Orange I and Orange II which are examples of acid dyes can be obtained by coupling diazotized sulphonic acid with α- and β-naphthol

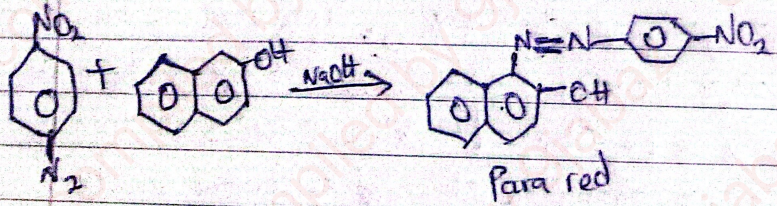


orange I



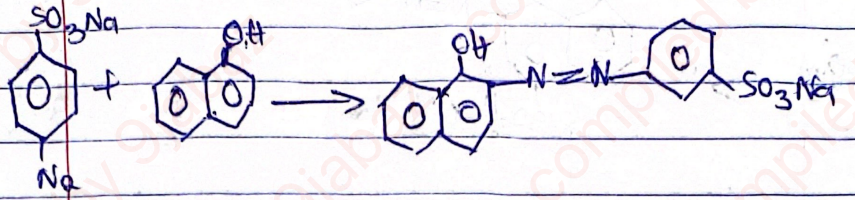
Para Red

Para red are used in foodstuffs, cosmetics, drugs and as an indicator



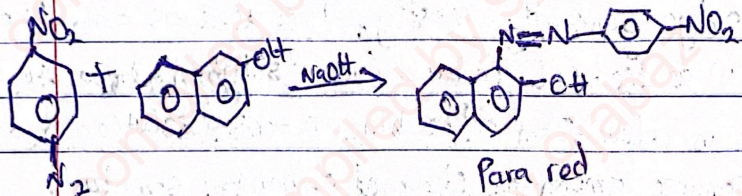
Para red

1-(4-nitrophenyl) diazenyl) naphthalene-2-ol



Para Red

Para red are used in foodstuffs, cosmetics, drugs and as an indicator



Para red

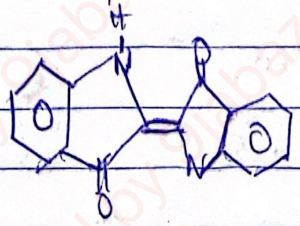
1-(4-nitrophenyl) diazonyl) naphthalene-2-ol

17/11/25

(2) Vat Dyes

They are insoluble in water so they cannot be used directly for dye. They are first reduced to soluble colourless form (leuco form) with a reducing agent such as an alkaline solution of sodium hydrosulphite. Under these conditions, the leuco form develops an affinity for cellulose fibres. Hence, these dyes are mainly used

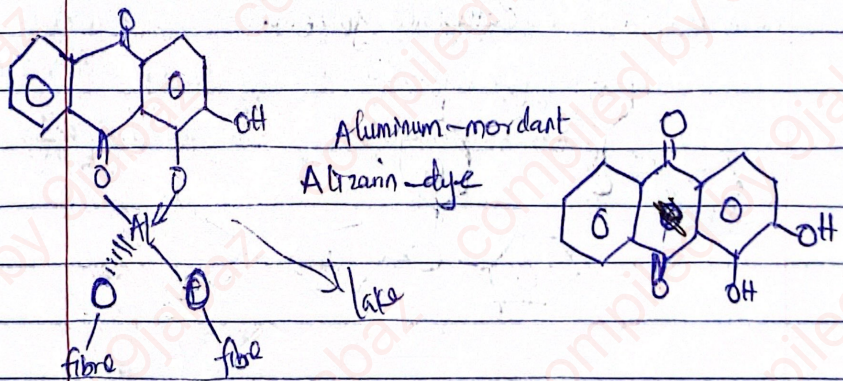
to dye cotton fibres. Example is indigo



structure of indigo

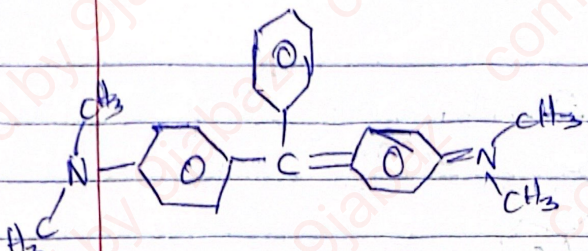
E-2,2 bi indilone

③ Mordant Dyes: These dyes do not bind directly but requires a mordant to bind to the fabric, so the mordant acts as the binding agent between the dye and the fabric. Metal ions are used as mordant for the acid dyes while tannic acid is used as mordant for the basic dyes

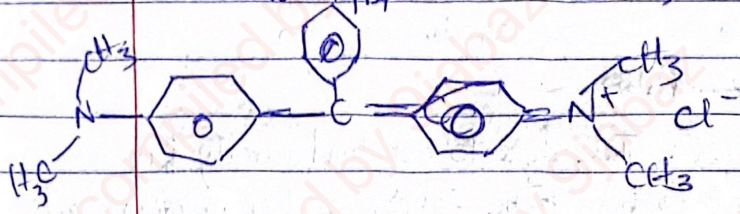


mordant red:

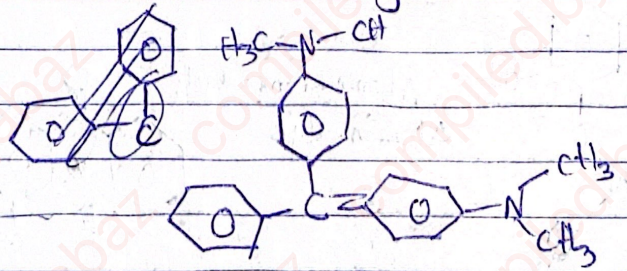
Malachite green is used for dyeing wool and silk directly and cotton mordanted with Phthalic. The colour of it fades slowly on addition of acid and base



When prepared as a Salt,

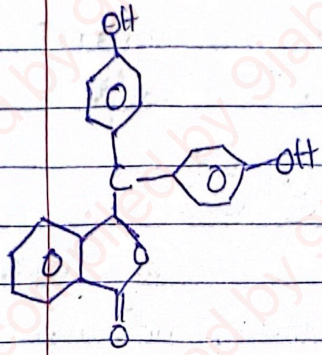


Crystal Violet: A weakly acidic solution of crystal violet is purple. Then in a strongly acidic solution (H_2SO_4, HCl etc) the colour is green. And still, in more acidic solution (more concentrated) the colour is yellow.

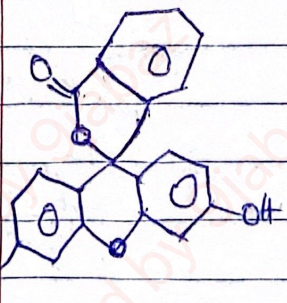


Pthalein dyes: An example is phenolphthalein. Phenolphthalein is insoluble in water but dissolves in alkalines to form a deep red solution. When excess of strong alkaline is added, the solution of phenolphthalein becomes colourless.

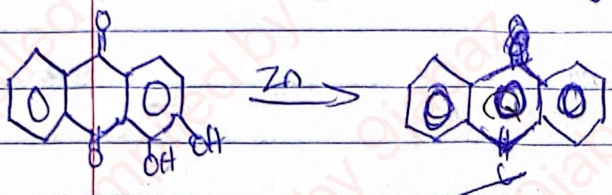
Because of the colour change, it is used as an indicator in acid base titration. It is also used as a powerful laxative.



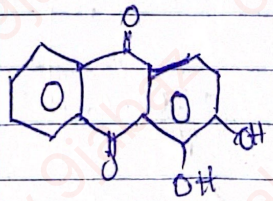
Florescein : It is a Zamtam derivative, it is more closely resemplem phthalein dyes. It is a red powder which is insoluble in water. It dissolves in alkaline to give a reddish brown in colour, which on dilution, it gives a strong yellowish-green florescence



Alizarine: It is one of the important anthraquinone dyes. It occurs in madder root in form of its glucoside called rubbertanic acid. On reduction with Zn dust, it gives anthracene



This implies that alizarine is a derivative of anthracene. It forms a ruby red crystals insoluble in water and alcohol, but dissolves in alkalines to form purple solution. It sublimes on heating. It is mordant dye and the colour of the lake depends on the metal used. Aluminium gives a red lake, ferric salt gives violet black, while chromium salt gives a brown-violet lake.



1,2-dihydroxyanthracene-9,10-dione

portant
nthraquinone dyes. It occurs
fuco ~~side~~ called rubbertanic
ist, it gives anthracene

derivative of anthracene. It
while in water and alcohol, but
purple solution. It sublimes
and the colour of the lake
which gives a red lake, ferric
le. Chromium salt gives

ition

PIGMENTS

These are organic and inorganic substances which are widely used as surface coatings. They are also used in ink, plastics, rubber etc, to impact colour. A large number of pigments are used for commercial manufacture of paints.

Classification of Pigments

Pigments are mainly classified into two;

(i) white pigments : ~~Group I~~
(ii) Coloured pigments: transition'd metals

White Pigment. They are various types, the compositions, properties and applications of some white pigments are as follows

Type	Chemical Compositions	
(i) White Lead	$2PbCO_3 \cdot Pb(OH)_2$	The composition of Lead carbonate is 68.9% while hydroxide is 31.8%. It is used in the manufacture of paints

Properties

(i) It is easily applied
(ii) It has high covering power
(iii) It is highly basic in nature
(iv) It yellows readily on exposure to atmosphere.
(v) It is soluble in alkaline

Type	chemical compositions	properties
② Sublimed white Lead (basic Sulfate)	$PbSO_4$ (75%), Pb PbO (20%) ZnO (5%)	(1) It has high specific gravity and refractive index (2) It slow chalken out of the film producing a rough surface
③ Zinc oxide	ZnO It is opaque to UV light and thus protects from UV (ii) It prevents chalking as well	(i) It is opaque to UV light and thus protects from UV (ii) It prevents chalking as well Properties (i) Brilliantly white hereby having (2) It causes discolourability even in contact with CO_2 gas. (3) It is more durable in combination with white Lead
④ Lithopone	ZnO (25-38%), $BaSO_4$ (72-78%) It is widely used for cold water Paint, traffic Paints, floor covering, and oil cloth industry	(1) Extremely fine and cheap Pigment. (2) It has a good hiding power. (3) It is not as durable as white Lead and ZnO
⑤ Titanium dioxide	It contains Titanium and iron oxide Fe_2O_3, TiO_2. It is widely used in paint, Paper and textile industry	(i) It has high capacity and hiding power (ii) It has high oil absorbing capacity (iii) spreading power is almost double

Properties

(i) It has high specific gravity and refractive index

(ii) It slow chalken out of the film producing a rough surface

(iii) It is opaque to uv light and thus protects from UV

(iv) No tendency for chalking

Blue pigment

Blue pigment: Ultra marine blue and cobalt

Blue Pigments: Ultra marine blue and cobalt blue are the most

There are three varieties of ultra marine, which are;
(i) blue (ii) white (iii) green.
It is used as bluing in laundry to neutralize the yellow stone in cotton and linen fabrics
White Ultra Marine Blue consists of $Na_6Al_3Si_3SO_{12}$
Green Ultra marine Blue consist of $Na_5Al_3S_{12}S_2O_{12}$
Blue Ultra Marine Blue $Na_7Al_3Si_2S_3O_{12}$

Properties

(1) Silicate skeleton has a potential influence on the colour
(2) Because of the presence of sulphur, it formed as a polysulphide s

Properties

(i) It has high specific gravity and refractive index
(ii) It slow chalken out of the film producing a rough surface
(iii) It is opaque to UV light and thus protects from UV
(iv) It prevents chalking as well

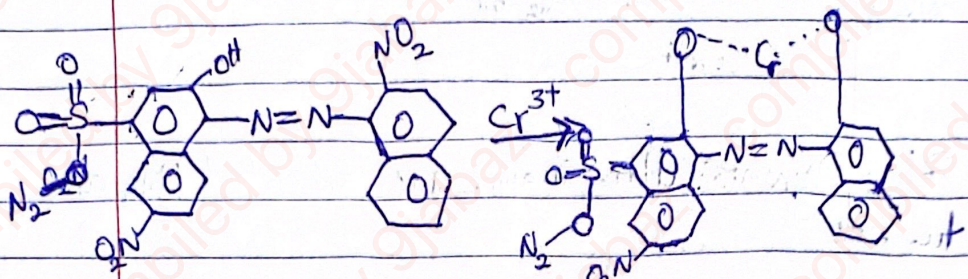
Properties

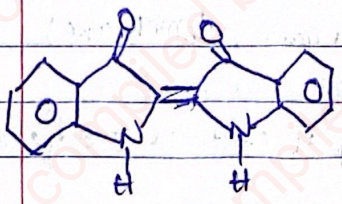
(1) Brilliantly white hereby having
(2) It causes discolouration even on contact with CO_2 gas
(3) It is more durable in combination with white Lead

(1) Extremely fine and cheap Pigment. (2) It has a good hiding power.
(3) It is not as durable as white Lead and ZnO
(1) It has high capacity and hiding power
(ii) It has high oil absorbing capacity
(iii) Spreading power is almost double

9, 10 continue

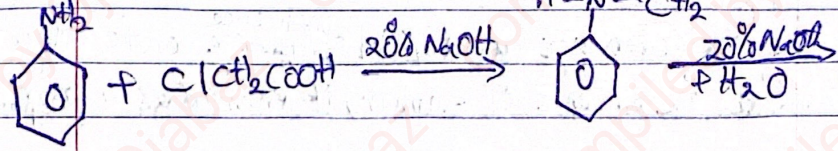
Mordant Dyes
with Cromium

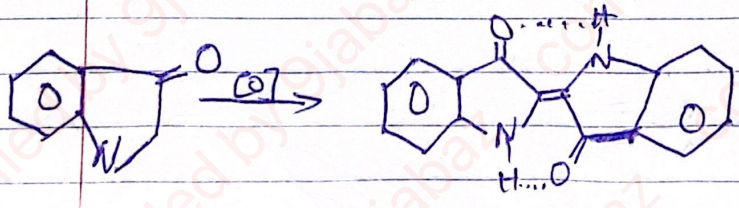




cis indigo

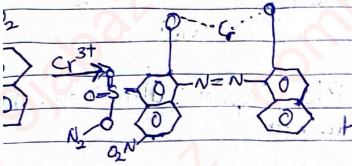
Synthesis of Indigo

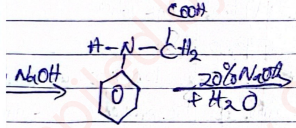


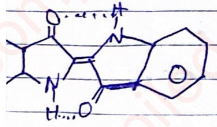


trans - indigo

q. 10 contin



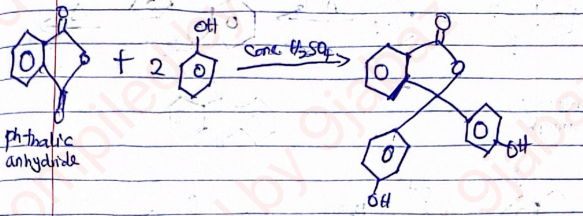




trans-Indigo

* Phenol is not an alcohol

phenolsulphophthalein

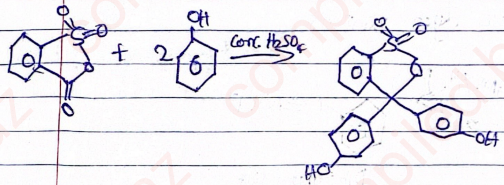


phthalic anhydride

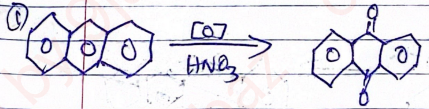
phenolphthaleine

Phenolsulphophthalein Synthesis

Sulphobenzoic anhydride is used instead of phthalic anhydride



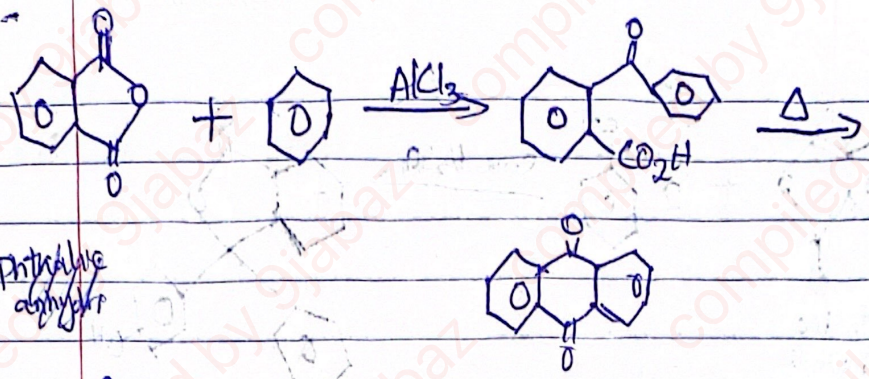
Anthraquinonone dye Synthesis



anthraquinone

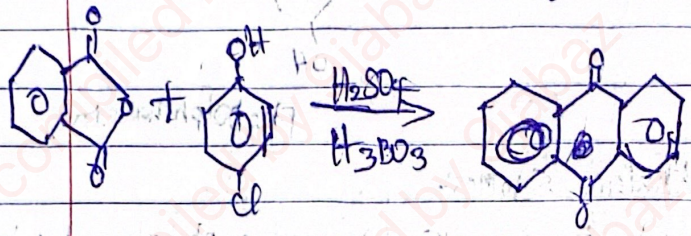
q. 10 anthraquinone

(2)

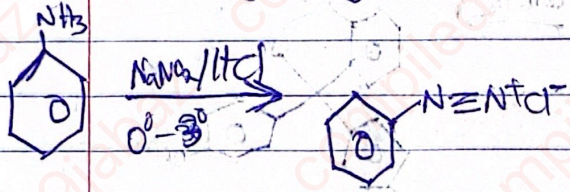


Phthalic anhydride

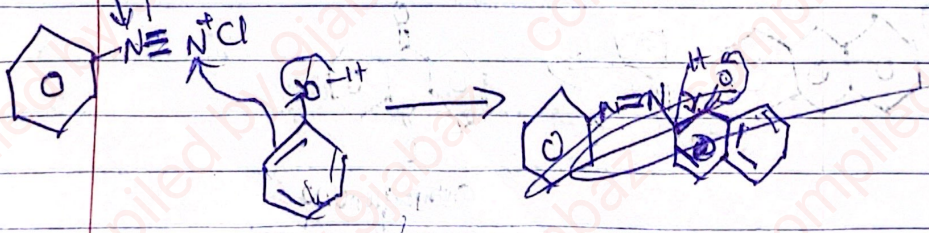
(3)



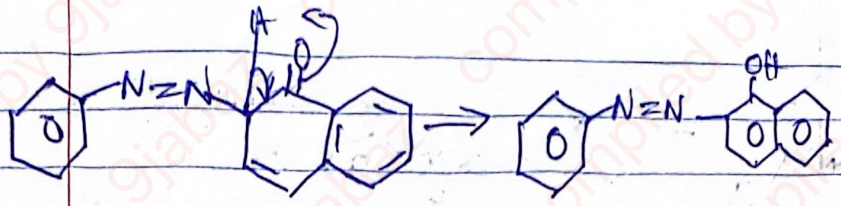
Benzoazo dyes Synthesis



Diazodized salt

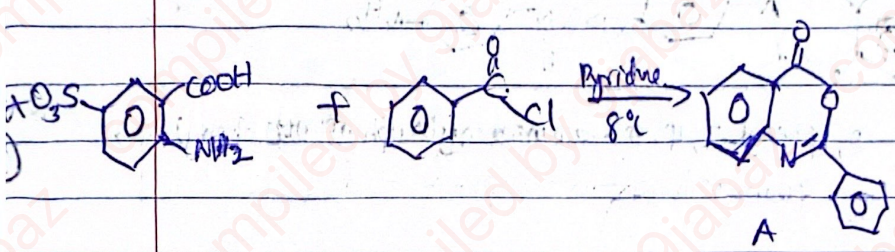


*Ester is electron deficient, electrophilic



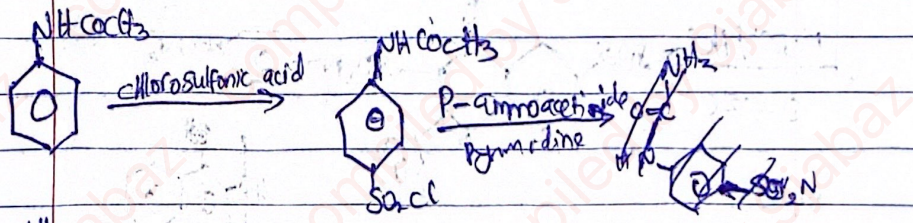
bright red

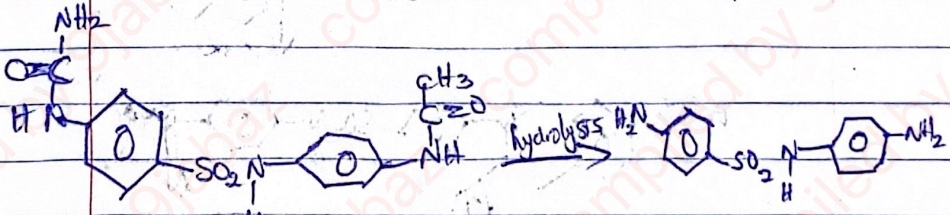
Synthesis of Quinazolin dyes



A

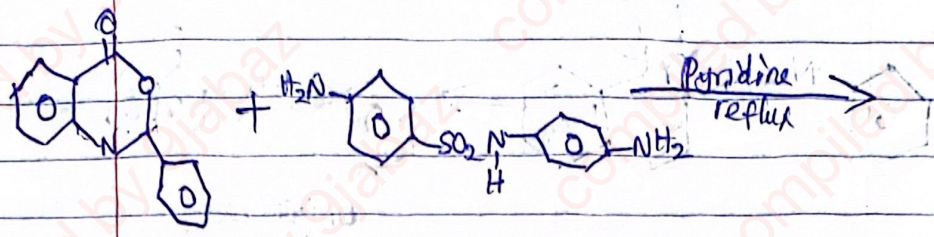
(2)

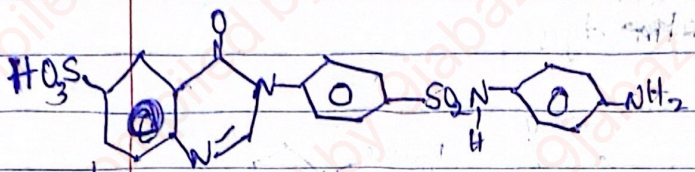




B

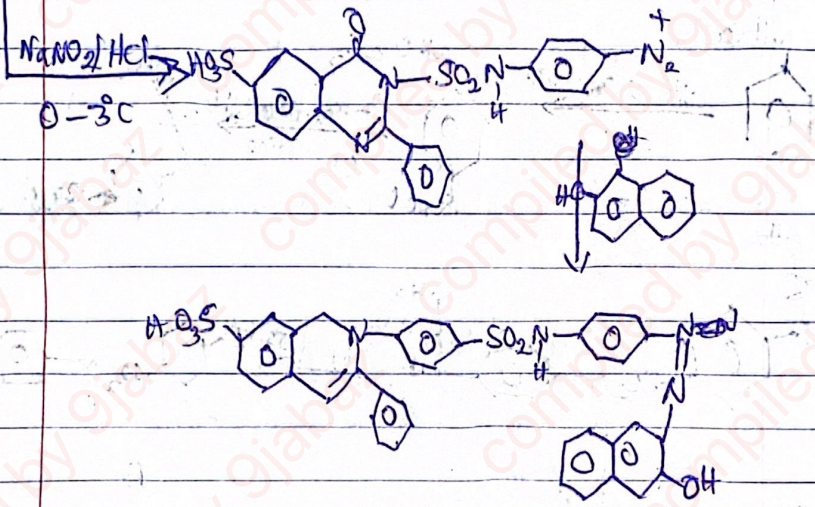
Reacting A and B,

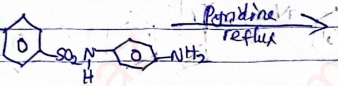


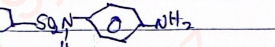


2, phenyl-3, 4', 4'-aminophenylsulphuramidophenyl-4-quinazoline-6-Sulphonic acid

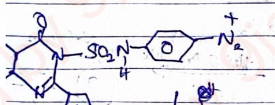
A

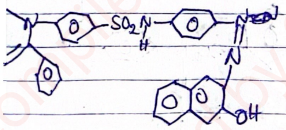


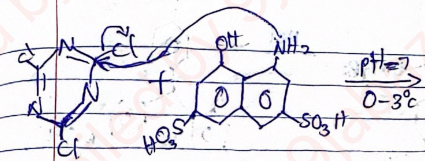


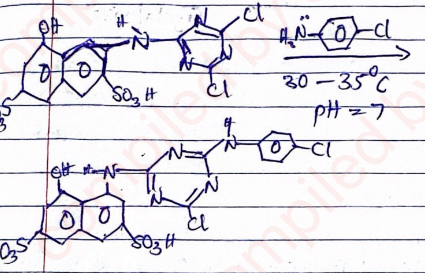


4'-aminophenylsulphuramidophenyl-α-
-6-Sulphonic acid



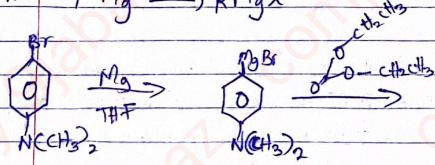


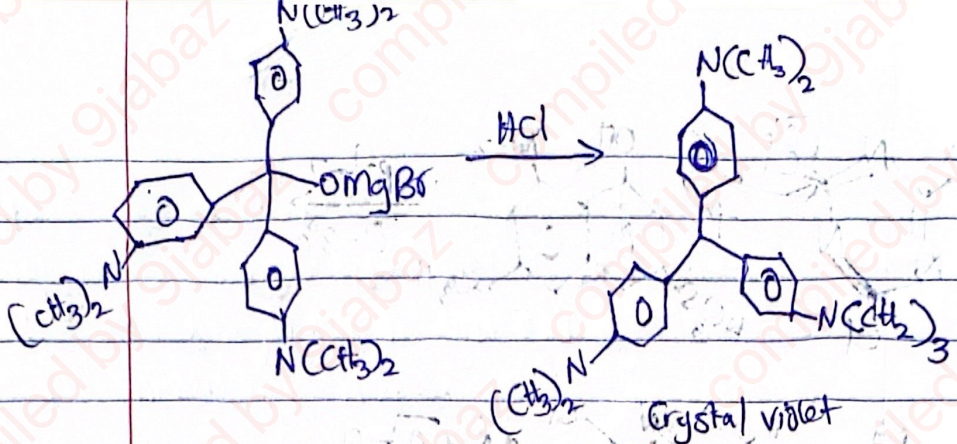




Synthesis of Crystal violet with Grignard Reagent

$$R\text{-}X + Mg \longrightarrow RMgX$$





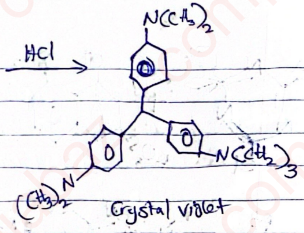
Aebeabraselies

1/12/25

Rubber

Rubber is a natural product made by plants and its also a very essential industry. Throughout the history of humanity and the rise of human civilization, rubber has played a significant role. Today we obtain 99% of the natural rubber produced

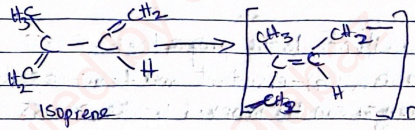
What is rubber? Rubber is a natural polymer that can stretch and shrink. It is an elastomer that after being deformed may revert back to its previous shape. Rubber is made by polymerization of isoprene (2-methyl-1,3-butadiene)



duct made by plants and its also a
ghout the history of humanity and
n, rubber has played a significant
19% of the natural rubber produced

a natural polymer that can
n elastomer that after being
to its previous shape
ulcanization of isoprene.

Carbon present



Hence, rubber is an elastic material produced from the emission of some tropical plant or extracted from petroleum and or natural gas. Rubber is an elastic flexible and tough substance, therefore it can be used to manufacture tyres for vechicles, aircraft, bicycle, etc.

Types of rubber

(i) Natural rubber (we can also have vulcanized rubber)
(ii) Synthetic rubber

(i) Natural rubber: This is the type of rubber obtained naturally from the milky liquid or latex obtained from the rubber tree. It is also known as india or gum rubber.
Natural rubber can be vulcanized into many different types of rubber products.

Properties

(i) It is not resistant to heat, so it melts easily at a temperature about 80°C

(II) It has excellent elastic properties
(III) It is abbrasion-resistant and tear-resistant
(IV) It Strength can be improved by the process called Vollcanization of rubber

Preparation of Natural Rubber

The latex sap of the rubber tree is used to make natural rubber. The latex is harvested by affixing a container to the rubber tree which is reffered to as tapping. After which formic acid is used to coagulate the latex. This rubber is then completely dried either with a series of rollers or by allowing them to air dry for several days under the natural air

This natural rubbers are now ready for processings to make a series of products.

Synthetic Rubber

From the word synthetic, it means it's a man made or artificial polymer. Any artificial elastomer is reffered to a synthetic rubber. Synthetic rubber is typically made up of additional polymers of Polyene monomers.

What is elastomer? An elastomer is a material that has the mechanical properties or being able to bend far more elastically under stress than most materials while still returning to its original size without permanent distortion.

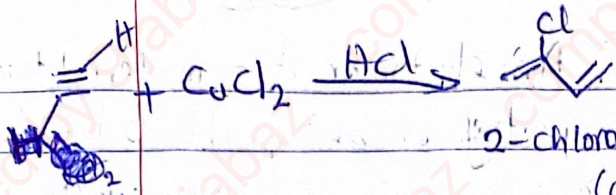
In many circumstances, synthetic rubber can be used in the place of natural rubbers especially where better material qualities are required.

An example of synthetic rubber is Neoprene which is made up of monomer unit, chloroprene.

Synthetic of Neoprene

Neoprene, commonly known as polychloroprene is a homopolymer made from chloroprene polymerized by free radicals. It has a strong oil resistance and it is used to make convoy belt, hoses and gasket among others.

The conventional method for synthesizing monovinyl acetylene involves a series of reactions initially acetylene was allowed to react with cuprous copper chloride and the resulting compound was subsequently treated with HCl to produce chloroprene



2-chlorobuta-1,3-diene
(chloroprene)

The process of Neoprene synthesis involves utilization of Chloroprene free radical polymerization mechanism. The polymer is synthesized via the addition of free radical emulsion.

The initiation of the polymerization process is achieved by employing $K_2S_2O_8$ Potassium persulphate
A variety of substances like bifunctional nucleophiles or metal oxides e.g zinc oxides, thiourea are used to make easier for polymer chains to link up with each other

The process of emulsification of chloroprene in water, followed by polymerization catalyzed by free radical initiators enables the transformation of chloroprene into rubber

The chloroprene repeating unit demostrate capacity to adopt various structures along the polymer chain with trans polychloroprene being the predominate configuration.

Buna-S

Buna-S is formed by co-polymerization of 1,3-butadiene and styrene. It has a high tensile strength and can be used as natural rubber alternatives. It is utilized to create car tyres, footwear components, cable insulators, etc.

Buna-N

Buna-N is a copolymer made by polymerizing 1,3-butadiene with acrylonitrile in the presence of peroxide catalyst. It is resistant to oils, petrol and some organic solvents. Therefore they are typically utilized to make tank linings and oil seals

Vulcanized Rubber

Vulcanized rubber is an elastomer that has been strengthened by the biochemical process of Vulcanization. A curing agent typically sulphur is mixed with the milky latex of the rubber tree and heated under pressure

What is Vulcanization? Vulcanization is a process of hardening rubbers. The term originally comes solely from the reaction of natural rubber and sulphur. Which is the most common practice. But it is also also

grown to increase the hardening of other synthetic rubber via various means. For example, Silicon rubber

Also chloroprene rubber, e.g ~~neoprene~~ ~~compounding~~

~~Process of Rubber~~

(i) Compounding
(ii) mixing
(iii) Shaping
(iv) Vulcanization

(I) Compounding: Rubber is ~~formulated~~ formed with additives and chemicals to improve its tensile strength and characteristics Carbon blacks, fillers, are added to rubber to boost its tensile strength and prevent it from ultraviolet ~~degrada~~ radiation degradation

(II) Mixing: Rubber must be well mixed with additives before it is used. The temperature is raised for this purpose and the additives are thoroughly blended. It takes place at very high temperature.

(III) Shaping: Extrusion, calendering, moulding or

coating and casting are four common Method for shaping rubber items

Extruders force a highly plastic rubber through a series of screw extruders to create rubbers. Calendering follows this phase which involves passing the rubber through a series of rubber gaps through a series of smaller gaps between rollers. This roller-die method combines extrusion and calendering to create a superior result.

The coating is the application of a rubber coat or the pushing of rubber into cloth or other materials. Rubber coating are used to make tyres, water proof textile tents, raincoats, convoy belts and other items Moulding or moulds are used to make rubber products such as as shoe soles, heels, suction cups, seals, and bottle stops.

~~(v) Vulcanization~~

(v) Vulcanization: The rubber-processing process is finished with vulcanization. Sulphur cross-connections between rubber polymers are formed during vulcanization Rubbers that has fewer cross-connection between its polymers is soft.

The elasticity of the rubber is reduced as the number of cross-connection increase.

Uses of Rubber

(1) One of the largest consumer of rubber is the tyre and tube industry. To make natural rubber more durable, it is combined with synthetic rubber

(2) Rubber is employed in other areas of the vechicle or automobile. e.g seals and various types of cushion for different car parts are made from natural rubber. Other examples are breakpads, seals, window, windshield seals in automobiles

(3) Rubber is used to produce airbags, which protect passenger from damage caused by accident

(4) Clothing: because natural rubber is elastic in its fibrous form it is utilized to make clothing that is tight fitting and expandable. Such as swimmers and cycling short

(5) Rubber is utilized to make flooring in variety of business establishment, kitchens and even playground. It creates cushion surface that

also slip resistant and water proof.