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CHEMISTRY

INORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	AMINES
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	10
TOTAL MARKS	57

Amines - 1

1.

(a)

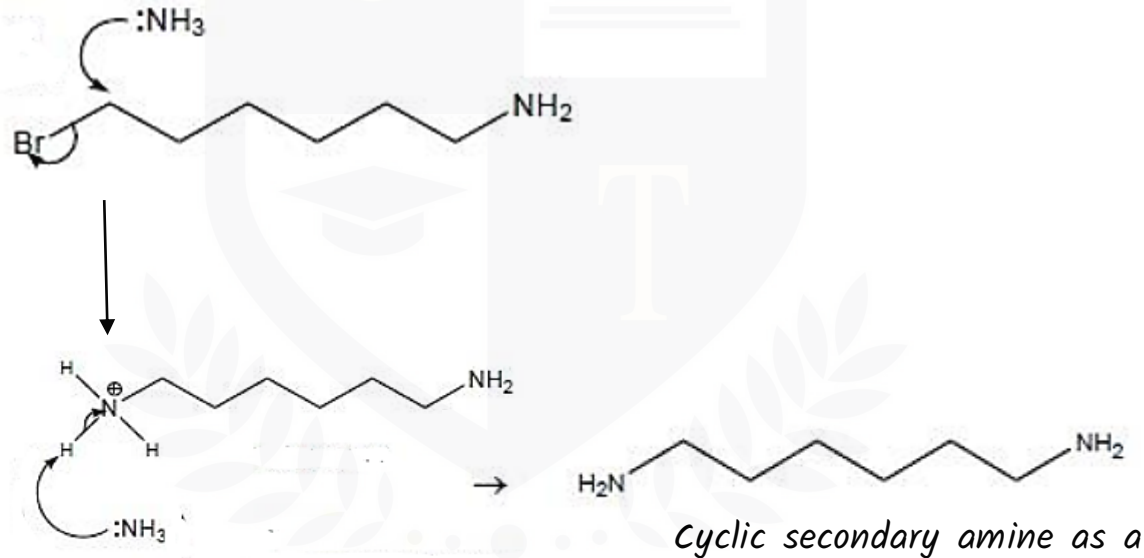
Equation for the preparation of 1,6-diaminohexane can be written as:

$Br\text{-}(CH_2)_6\text{-}Br + 4NH_3 \rightarrow H_2N\text{-}(CH_2)_6\text{-}NH_2 + 2NH_4Br$

(2)

(b)

Following is a mechanism for the reaction of ammonia with 6-bromohexylamine to form 1,6-diaminohexane.



Cyclic secondary amine as a by-product:

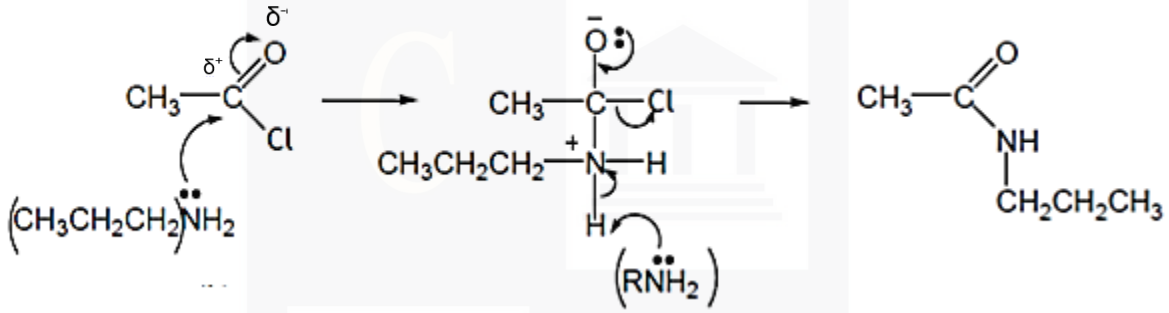
(4)

2.

Name of the mechanism:

(Nucleophilic) Addition

Mechanism:



IUPAC name of the organic product:

- *N-(n-Propyl)acetamide*

(6)

3.

(a)

1,4-dinitrobenzene 1,4-diaminobenzene

This reaction is reduction / redox reaction.

(1)

(b)

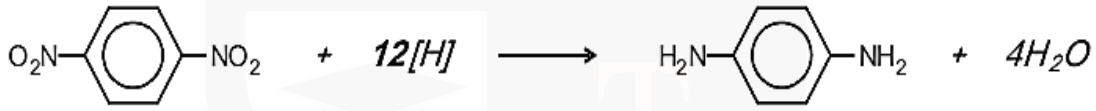
Reagents and conditions:

- ***Tin and HCl:***
  - ***Reagents:*** *Tin (Sn) and Hydrochloric acid (HCl)*
  - ***Conditions:*** *Reflux*
- ***Hydrogen gas with Nickel/Palladium Catalyst:***
  - ***Reagents:*** *Hydrogen gas (H2), Nickel (Ni) or Palladium (Pd) catalyst*
  - ***Conditions:*** *Under high pressure and temperature, typically with the catalyst at room temperature or slightly elevated.*

(2)

(c)

Balance equation for this reaction:



(2)

4.

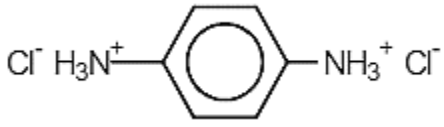
(a)

The amino groups in a primary amine, like 1,4-diaminobenzene, act as bases by accepting a proton (H^+) using the lone pair of electrons on the nitrogen atom, forming a dative covalent bond and neutralizing the basicity of the molecule.

(2)

(b)

Structure of the salt:



(2)

(c)

Hexane-1,6-diamine is expected to be a stronger base because:

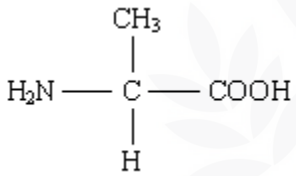
- *Electrons move towards the nitrogen atom due to the inductive effect in hexane-1,6-diamine.*
- *The lone pair from nitrogen in hexane-1,6-diamine is partially delocalized around the ring, facilitating easier donation of electrons.*

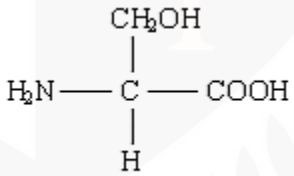
These factors contribute to the electron pair being more easily donated and a proton (H^+) being more readily accepted in hexane-1,6-diamine compared to 1,4-diaminobenzene.

(3)

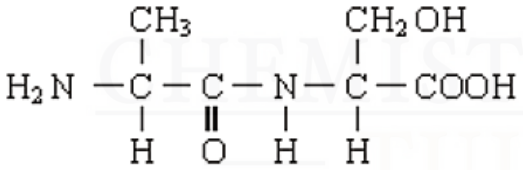
5.

Following are the two dipeptides which can form when one of the amino acids shown below reacts with the other.

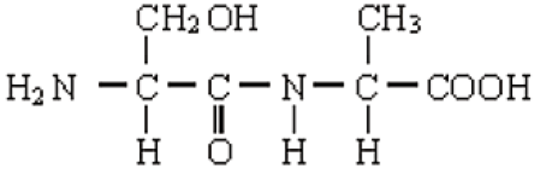




Structure 1:

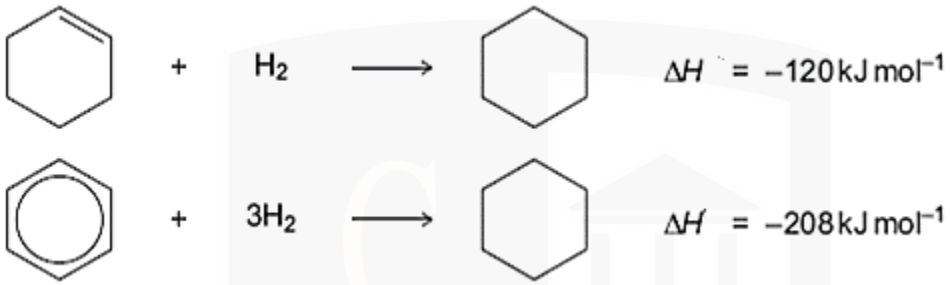


Structure 2:



(2)

6.



Benzene is more stable than cyclohexatriene.

This is evident from the comparison of their expected and actual enthalpies of hydrogenation (ΔH).

The expected ΔH for benzene is calculated to be
$3 \times (-120) = -360$ kJ mol^{-1}

Indicating that the hydrogenation of benzene should release 360kJ of energy per mole of benzene.
This is three times the ΔH of cyclohexene.

However, the actual ΔH for benzene is measured to be 152 kJ mol^{-1}, which is significantly less exothermic than expected.

This deviation from the expected value is due to the delocalization of electrons or resonance within the benzene ring.

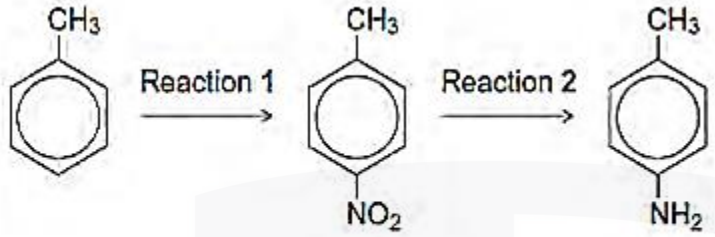
Due to this delocalization, the energy released during hydrogenation is less than expected, making benzene more stable than predicted based solely on the number of double bonds.

I am Sorry !!!!!

(5)

7.

(a)

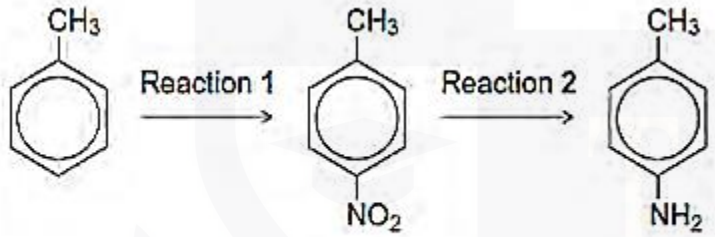


J

Name of mechanism electrophilic substitution.

(1)

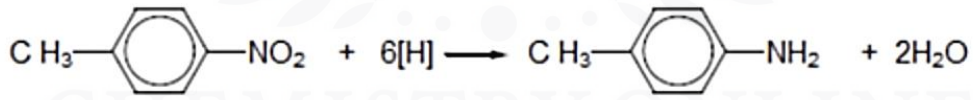
(b) *For reaction 2*



J

Reducing agent for this reaction is Sn / HCl.

Equation for this reaction:



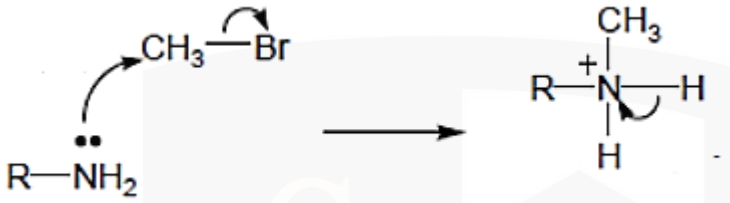
This compound is used in making dyes

(3)

(c)

Mechanism for the reaction of bromomethane with an excess of compound J.

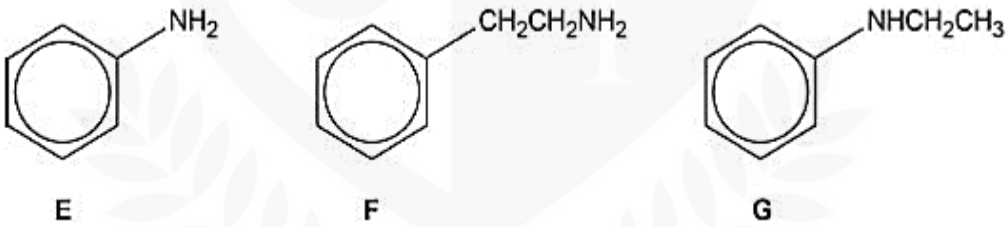
J as RNH_2 in the mechanism:



(4)

8.

(a)



For amine E, its lone pair is delocalized into the ring structure next to the nitrogen atom, which reduces its availability for proton acceptance.

- This results in a situation where the lone pair is less available to donate to or accept a proton.

For amines F or G, the nitrogen atom is positioned next to an alkyl group, leading to a positive inductive effect where electrons are pushed towards the nitrogen atom.

- Consequently, the lone pair on the nitrogen atom of F or G becomes more available for donation or acceptance of a proton.
- Thus, based on the availability of the lone pair on the nitrogen atom, the order of increasing base strength is E < G < F, or alternatively,

- F is the most basic and E is the least basic among the three amines.

(6)

(b)

Product of step 1 $C_6H_5CH_2Br$

Product of step 2 $C_6H_5CH_2CN$

- **Step 1:**

  Halogenation (Chlorination/Bromination)

  - Reagents and Conditions: Chlorine gas (Cl_2) with UV light OR Bromine (Br_2) with UV light
  - Intermediate Compound: Chloromethylbenzene or Bromomethylbenzene

- **Step 2:**

  Cyanide Addition

  - Reagents and Conditions: Potassium cyanide (KCN) in alcoholic and aqueous medium
  - Intermediate Compound: Phenylacetonitrile

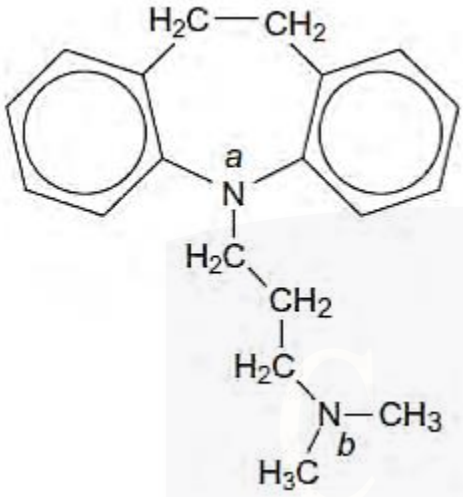
- **Step 3:**
  Reduction of Nitrile Group

  - Reagents and Conditions: Hydrogen gas (H_2) with a catalyst such as nickel ($NiNi$), platinum (Pt), or palladium (Pd)
  - Final Product: Amine F

(5)

9.

(a)



The lone pair on nitrogen labeled "b" is more readily available for donation compared to the lone pair on nitrogen labeled "a."

As the lone pair or electron density on the nitrogen labeled "a" is delocalized into the benzene ring.

(3)

(b)

Molecular formula of imipramine:

$C_{19}H_{24}N_2$

Imipramine indeed has 11 carbon atoms in its structure.

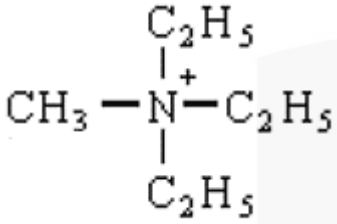
(2)

10.

Name the mechanism:

Nucleophilic substitution

Structure:



(2)

I am Sorry !!!!!

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