



CHEMISTRY ONLINE
— TUITION —

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CHEMISTRY

ORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	AROMATIC CHEMISTRY
PAPER TYPE:	SOLUTION - 2
TOTAL QUESTIONS	10
TOTAL MARKS	43

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Aromatic Chemistry - 2

1.

(a)

Equation:



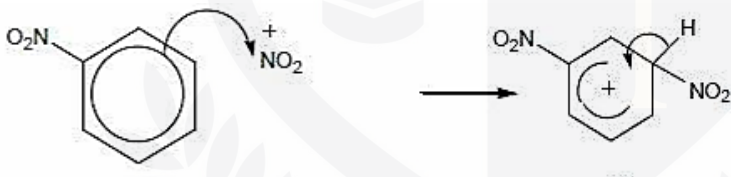
(1)

(b)

Name of the mechanism:

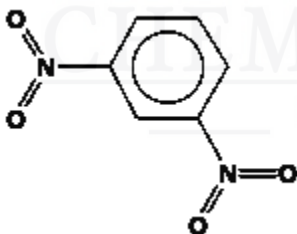
Electrophilic substitution.

Mechanism for the reaction of this species with nitrobenzene to form 1,3-dinitrobenzene:



Product:

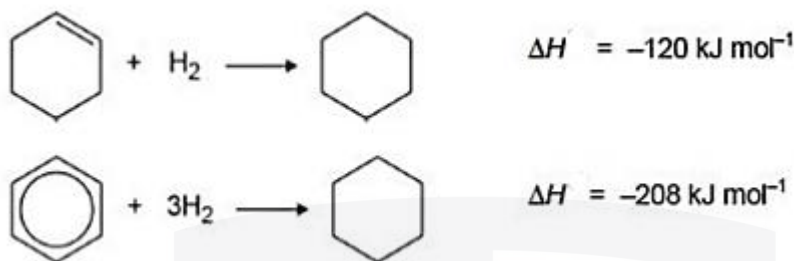
1,3-dinitrobenzene:



(4)

2. A

(1)

3.
(a)**Bonding in Benzene:**

In benzene, each carbon atom forms three covalent bonds. The spare electrons in the p orbitals of each carbon atom overlap to form a π cloud, resulting in delocalization of electrons throughout the ring.

Shape of Benzene:

Benzene adopts a planar structure with a hexagonal ring of carbon atoms. The bond angles are approximately 120°, and the carbon-carbon bonds have equal lengths due to delocalization, falling between the lengths of single and double bonds.

Stability of Benzene:

Comparing the stability of benzene with cyclohexatriene, the expected enthalpy change (ΔH°) for the hydrogenation of cyclohexatriene is -360 kJ mol⁻¹, whereas benzene's hydrogenation is less exothermic by 152 kJ mol⁻¹.

This significant difference indicates that benzene is more stable than cyclohexatriene due to its aromaticity and electron delocalization.

(6)

(b)

The value for the enthalpy of hydrogenation of cyclohexa-1,3-diene falls within the range of -239 to -121 kJ/mol.

This range gives the fact that the conjugation in cyclohexa-1,3-diene provides some stabilization compared to isolated double bonds in cyclohexene, but it is still higher than the enthalpy of hydrogenation of cyclohexene due to the presence of two double bonds.

The presence of double bonds separated by one single bond allows for some delocalization or overlap of p orbitals, which contributes to the stability of cyclohexa-1,3-diene.

Although this stabilization is not as strong as that seen in fully aromatic systems, it is sufficient to reduce the enthalpy of hydrogenation compared to the value expected if the double bonds were isolated.

So, a reasonable value for the enthalpy of hydrogenation of cyclohexa-1,3-diene within the provided range would be around -200 kJ/mol, considering the partial delocalization of electrons.

(3)

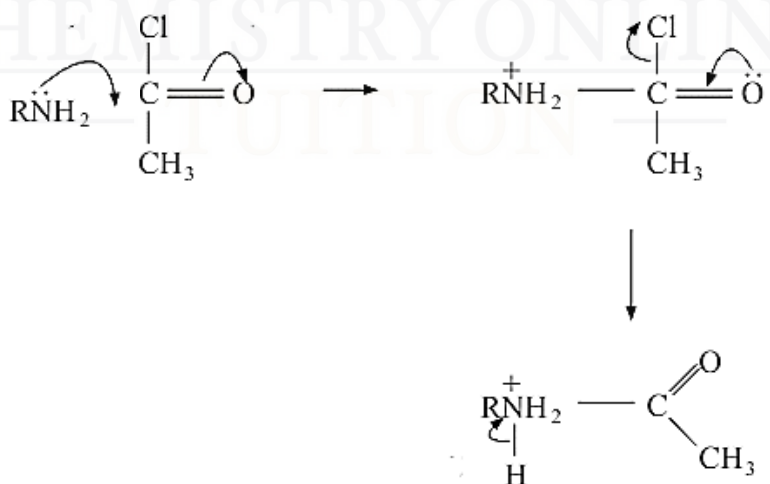
4. D

(1)

5.

Equation:**Name of mechanism:**

(nucleophilic) addition-elimination

Mechanism:

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Product:
 RNHCOCH_3

(6)

6. A

(1)

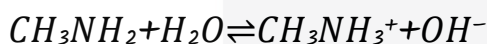
7.

(a)

A Bronsted-Lowry base is a substance that can accept a proton (H^+ ion).

It's a proton acceptor.

Equation for the Reaction of Methylamine with Water:



(2)

(b)

$\text{CH}_3\text{NH}_3\text{Cl}$ or HCl could be added to aqueous methylamine to produce a basic buffer.

(2)

(c)

When sodium hydroxide (NaOH) is added to the buffer solution containing methylamine (CH_3NH_2) and its conjugate acid (CH_3NH_3^+), any excess hydroxide ions react with CH_3NH_2 to form CH_3NH_3^+ and water.

The equilibrium shifts left, consuming the extra hydroxide ions.

The ratio of salt to base remains constant, maintaining the buffer's pH resistance.

(2)

(d)

Methylamine (CH_3NH_2) is a stronger base than ammonia (NH_3) because the presence of the methyl group (CH_3) increases electron density on the

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nitrogen atom, making the lone pair more available for accepting a proton (H^+).

This effect is due to the positive inductive effect of the methyl group.

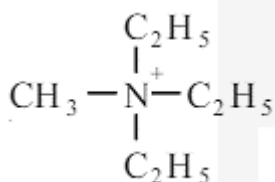
(2)

(e)

Name of the mechanism:

Nucleophilic substitution

The structure of the cation formed:

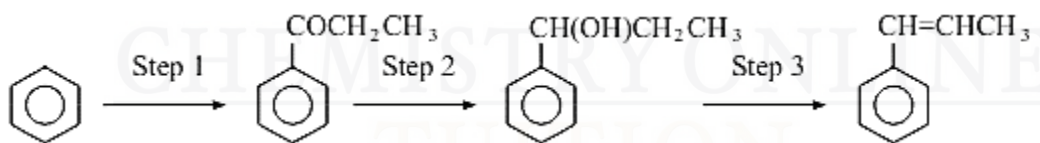


(4)

8. A

(1)

9.



For Step 1:

Reagent: $AlCl_3$

Type of reaction: *Electrophilic substitution*

For Step 2:

Reagents: NaBH_4 or LiAlH_4 or Na/EtOH

Type of reaction: reduction

For Step 3:

Reagents: H_2SO_4 or Al_2O_3

Type of reaction: Elimination

10. C

(6)

(1)



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