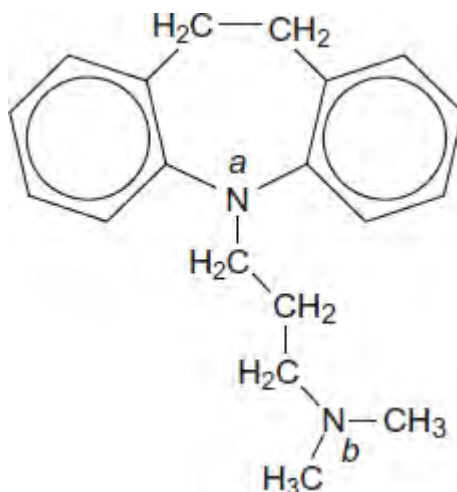


Q1. Imipramine has been prescribed as an antidepressant. The structure of imipramine is shown below.



- (a) The medicine is usually supplied as a salt. The salt is formed when one mole of imipramine reacts with one mole of hydrochloric acid.

Suggest why the nitrogen atom labelled *b* is more likely to be protonated than the nitrogen atom labelled *a* when the salt is formed.

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(3)

- (b) Deduce the molecular formula of imipramine and give the number of peaks in its  $^{13}\text{C}$  n.m.r. spectrum.

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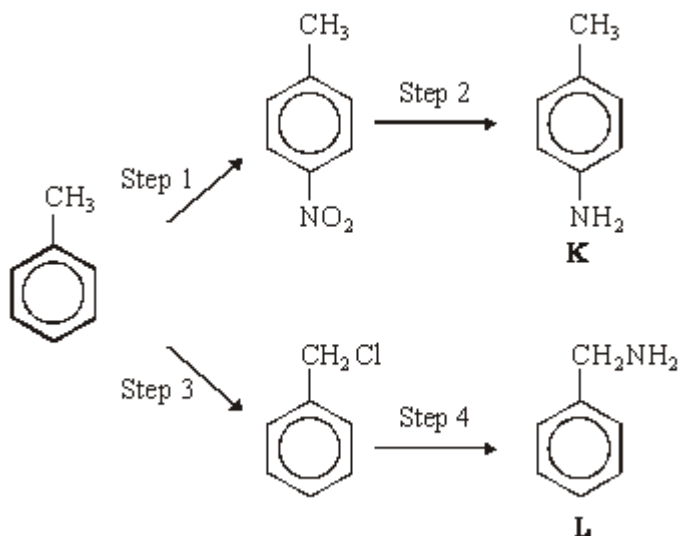
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**Q2.** The following reaction scheme shows the formation of two amines, **K** and **L**, from methylbenzene.



- (a) (i) Give the reagents needed to carry out Step 1. Write an equation for the formation from these reagents of the inorganic species which reacts with methylbenzene.

Reagents .....

Equation .....

- (ii) Name and outline a mechanism for the reaction between this inorganic species and methylbenzene.

Name of mechanism .....

Mechanism

(b) Give a suitable reagent or combination of reagents for Step 2.

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(1)

(c) (i) Give the reagent for Step 4 and state a condition to ensure that the primary amine is the major product.

*Reagent* .....

*Condition* .....

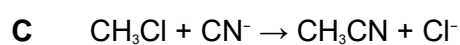
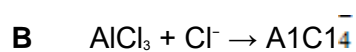
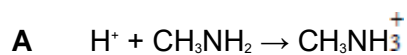
(ii) Name and outline a mechanism for Step 4.

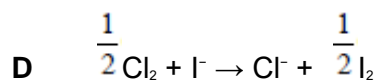
*Name of mechanism* .....

*Mechanism*

(7)  
(Total 15 marks)

**Q3.** Which one of the following reactions does **not** involve donation of an electron pair?

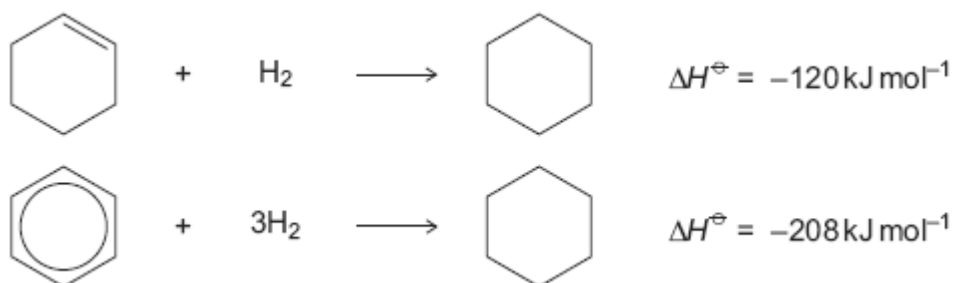




(Total 1 mark)

**Q4.** The hydrocarbons benzene and cyclohexene are both unsaturated compounds. Benzene normally undergoes substitution reactions, but cyclohexene normally undergoes addition reactions.

- (a) The molecule cyclohexatriene does not exist and is described as hypothetical. Use the following data to state and explain the stability of benzene compared with the hypothetical cyclohexatriene.



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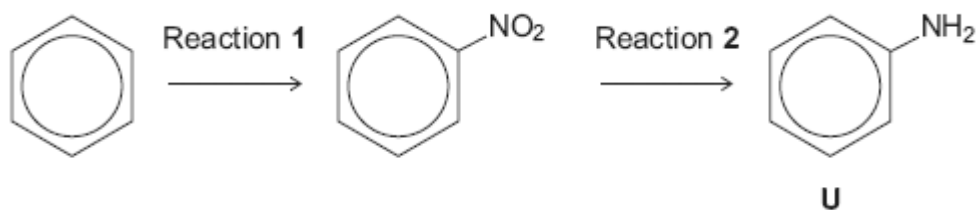
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(4)

- (b) Benzene can be converted into amine **U** by the two-step synthesis shown below.



The mechanism of Reaction 1 involves attack by an electrophile.

Give the reagents used to produce the electrophile needed in Reaction 1.

Write an equation showing the formation of this electrophile.

Outline a mechanism for the reaction of this electrophile with benzene.

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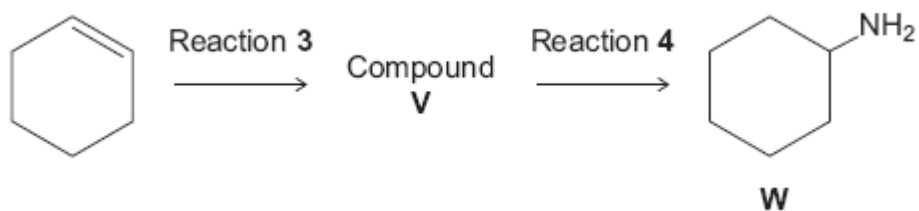
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(6)

- (c) Cyclohexene can be converted into amine **W** by the two-step synthesis shown below.



Suggest an identity for compound **V**.

For Reaction **3**, give the reagent used and name the mechanism.

For Reaction **4**, give the reagent and condition used and name the mechanism.

Equations and mechanisms with curly arrows are **not** required.

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(Extra space) .....

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(6)

(d) Explain why amine **U** is a weaker base than amine **W**.

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(Extra space) .....  
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(3)  
(Total 19 marks)