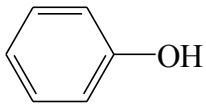
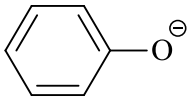
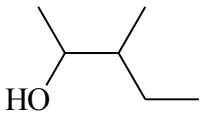
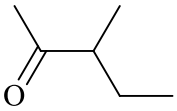
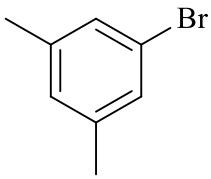
**Marks 3**

- Complete the following table. Make sure you complete the name of the starting material where indicated.

| STARTING MATERIAL | REAGENTS/ CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|  Name: **phenol** | dilute NaOH |  |
|  | $Na_2Cr_2O_7$ in dilute sulfuric acid |  |

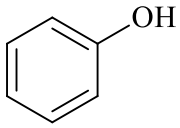
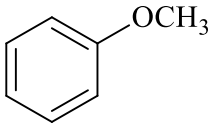
- Complete the following table. Make sure you complete the name of the starting material where indicated.

**Marks 1**

| STARTING MATERIAL | REAGENTS/ CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|   | 1. Mg / dry ether<br>2. $CO_2$<br>3. $H^{\oplus}$ / $H_2O$ | |

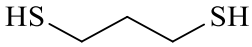
- Complete the following table. Make sure you complete the name of the starting material where indicated.

**Marks 1**

| STARTING MATERIAL | REAGENTS/ CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|   | 1. NaOH<br>2. $CH_3I$ |   |

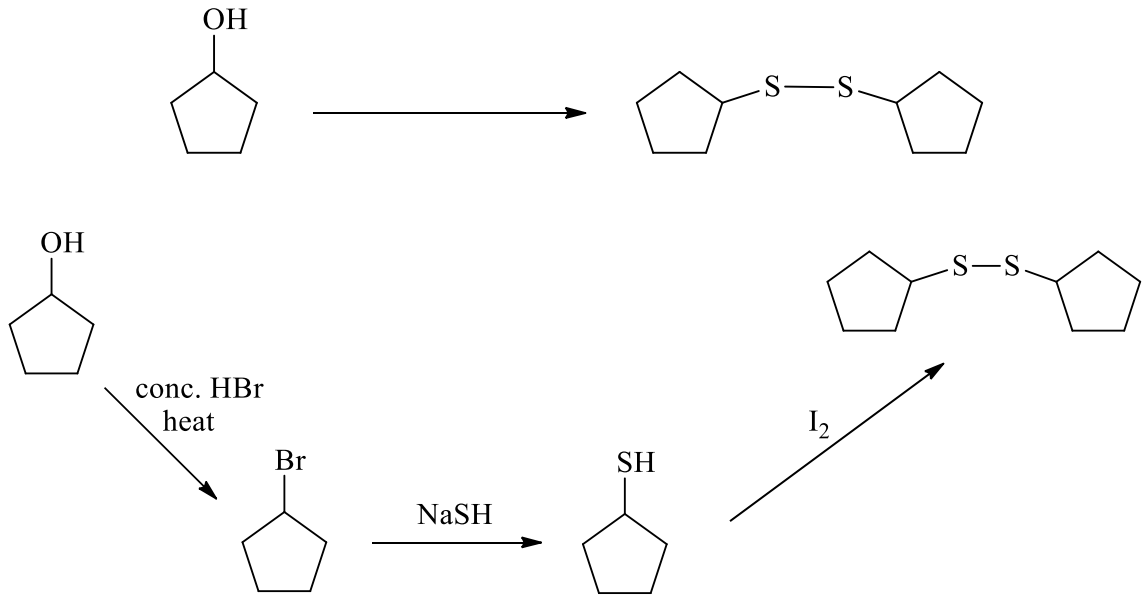
- Complete the following table. Make sure you complete the name of the starting material where indicated.

**Marks 1**

| STARTING MATERIAL | REAGENTS/ CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|  | **Zn / $H^+$** |  |

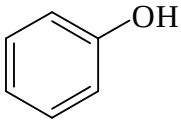
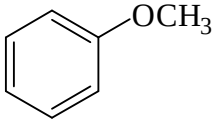
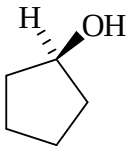
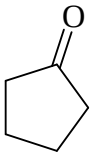
- Show clearly the reagents you would use to carry out the following chemical conversions. Note that more than one step is required and you should indicate all necessary steps and the constitutional formulas of any intermediate compounds.

Marks
**2**



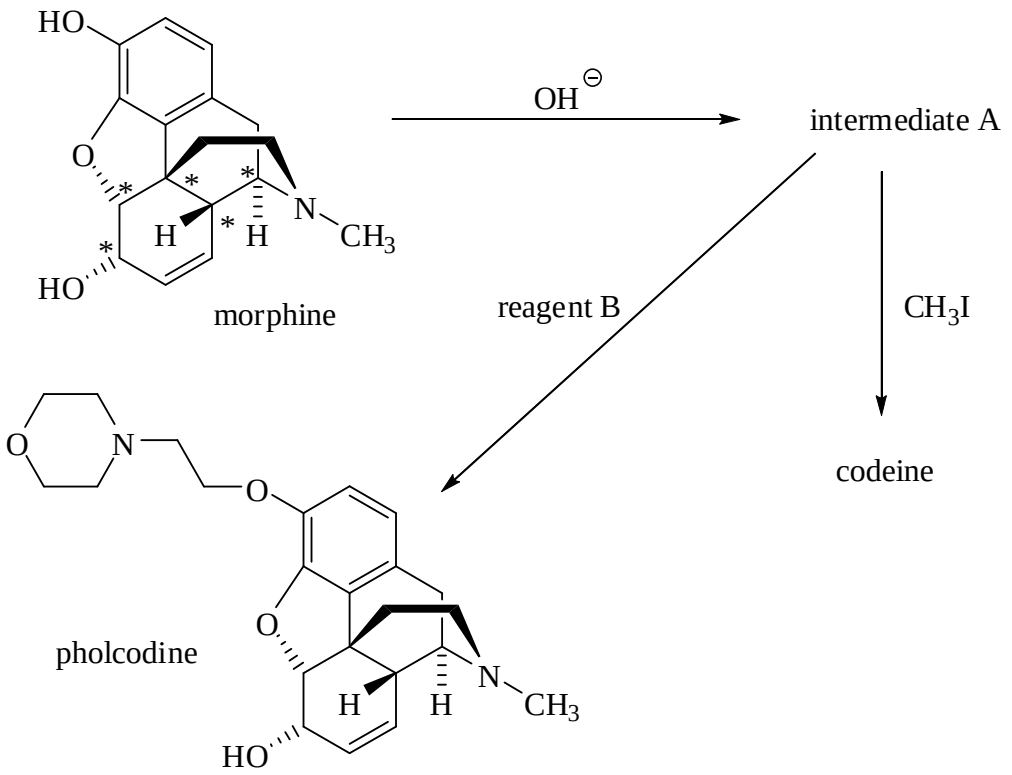
**Marks 3**

- Complete the following table. Make sure you complete the name of the starting material where indicated.

| STARTING MATERIAL | REAGENTS/ CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|  | **1. NaOH**<br>**2. $CH_3I$** |  |
|  | $Cr_2O_7^{2\ominus}$ / $H^{\oplus}$ |  |

**Marks 7**

- Morphine is the principal active agent in opium and is a highly potent analgesic drug. Its structure and conversion into codeine (a moderate analgesic) and pholcodine (a cough suppressant) are shown below.




Give the molecular formula of morphine. **$C_{17}H_{19}O_3N$**

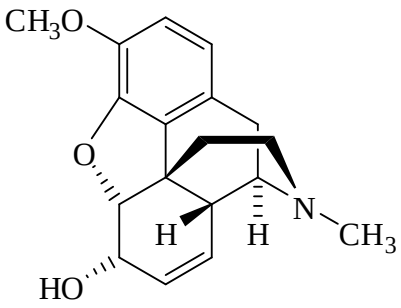
How many stereogenic (chiral) centres are there in morphine? **5 (* on picture)**

Identify the functional groups present in morphine.

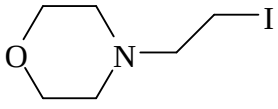
**phenol, amine, alcohol, ether, alkene**

Draw the structures of codeine and reagent B.

codeine

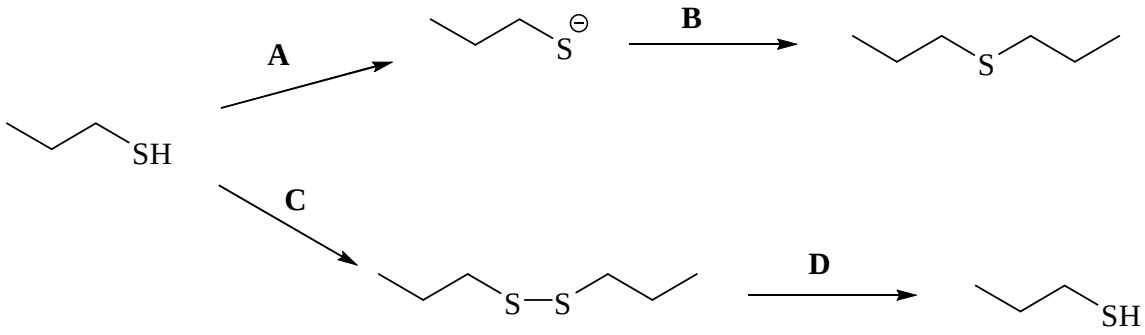



reagent B



**Marks 5**

- Indicate the reagents used in the laboratory to undertake the following transformations.

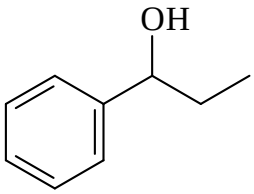



| | |
|---|---|
| **A**: | **NaOH** |
| **B**: | **$CH_3CH_2CH_2Br$** |
| **C**: | **$I_2$** |

| | |
|---|---|
| Provide a description for transformation **B**. | **nucleophilic substitution** |
| Provide a description for transformation **D**. | **reduction** |

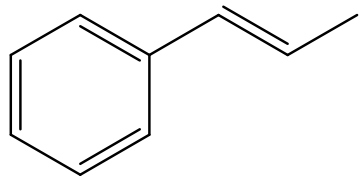
**Marks 6**

- 1-Phenyl-1-propanol (**J**) is treated with concentrated sulfuric acid to give a mixture of two alkenes (**K**) and (**L**). Alkenes (**K**) and (**L**) are diastereomers. Give the constitutional formulas for (**K**) and (**L**).

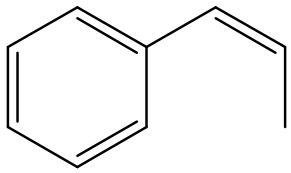



(**J**)

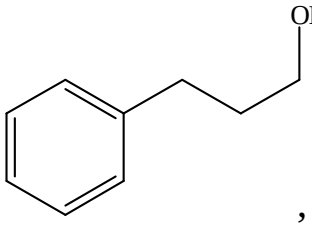
(**K**)



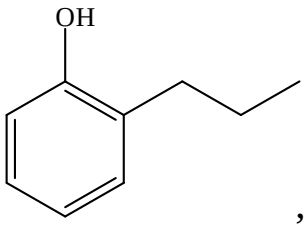
(**L**)



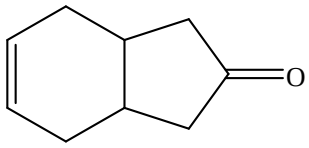
Give the structure of a constitutional isomer of (**J**).




,

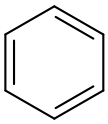


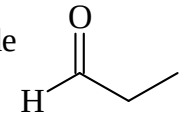

,

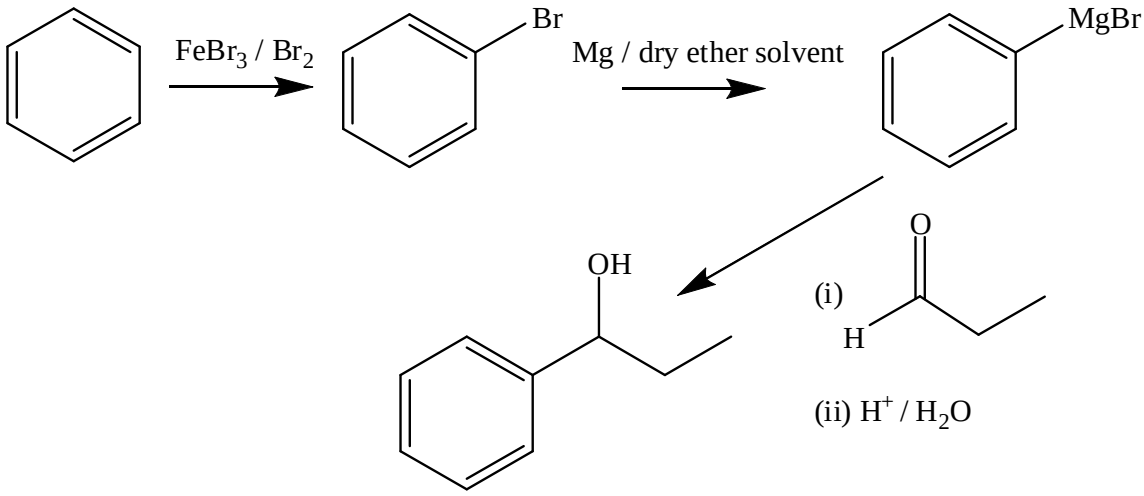



**and many others**

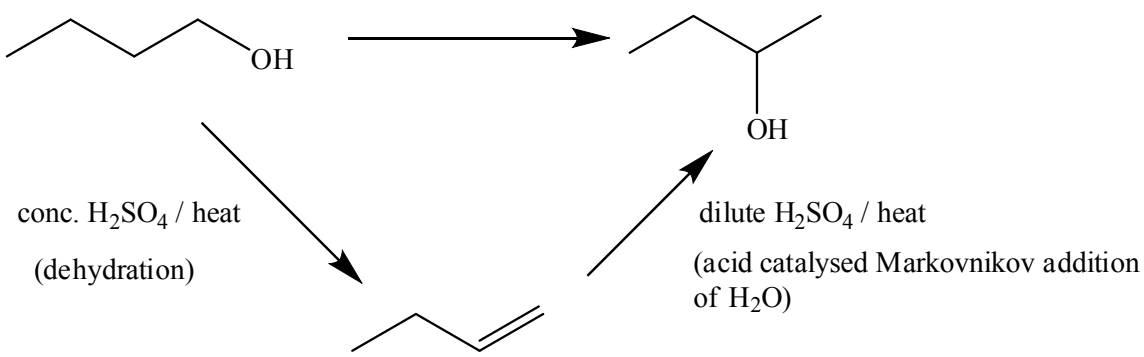
Outline a reaction sequence that converts benzene into 1-phenyl-1-propanol (**J**) and that also uses propionaldehyde as a reactant somewhere in the sequence. Any solvents and inorganic reagents may be used. More than one step is required. Show clearly the reagents you would use and draw constitutional formulas for any intermediate compounds.

benzene 

propionaldehyde (propanal) 

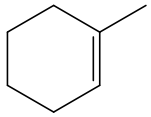
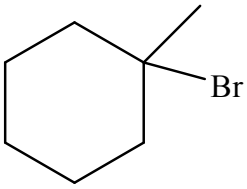
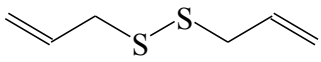
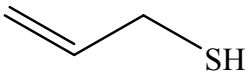



| | Marks |
|---|---|
| • Show clearly the reagents you would use to carry out the following chemical conversions. Draw constitutional formulas for any intermediate compounds. Note: More than one step is required in both cases. | **3** |



- Complete the following table. Make sure you give the name of the product or starting material where requested.

**Marks 3**

| STARTING MATERIAL | REAGENTS/CONDITIONS | CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S) |
|---|---|---|
|  **Name: 1-methylcyclohex-1-ene** | $HBr / CCl_4$ (solvent) |  **(Markovnikov product with Br on more substituted end of double bond)** |
|  | $Zn / H^{\oplus}$ | **2**  |