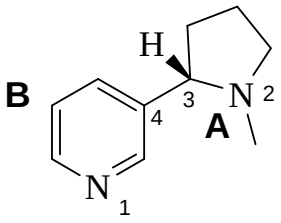
- Hydrogen bond strength increases in the order N–H ::::N < O–H:::O < F–H::::F. Use this information and the data given in the table to explain the differences in boiling point of ammonia, water and hydrogen fluoride.

**2**

| Compound | $NH_3$ | $H_2O$ | HF |
|---|---|---|---|
| Boiling point / °C | –33 | 100 | 20 |

**Marks 5**

- The molecular structure of nicotine, the addictive component of tobacco, is shown below.




List the types of intermolecular interactions that each of the following sites on nicotine would be involved in when it is dissolved in water.

| |
|---|
| **A** |
| **B** |

Provide the requested information for each of the indicated atoms in nicotine.

| Atom | Geometric arrangement of the electron pairs around the atom | Hybridisation of the atom | Geometry around the atom |
|---|---|---|---|
| N-1 | | | |
| N-2 | | | |
| C-3 | | | |
| C-4 | | | |

**3**

- Consider the boiling points of the compounds 1-propanol, 1-propanethiol and 1-propaneselenol shown in the table below?

| Compound | $CH_3CH_2CH_2OH$ | $CH_3CH_2CH_2SH$ | $CH_3CH_2CH_2SeH$ |
|---|---|---|---|
| Boiling point (° C) | 97.2 | 67.8 | 147.0 |

With reference to intermolecular forces, explain briefly why the boiling points increase in the order $CH_3CH_2CH_2SH < CH_3CH_2CH_2OH < CH_3CH_2CH_2SeH$.

Marks

- Complete the following table. Give, as required, the formula, the systematic name, the oxidation number of the underlined atom and, where indicated, the principal ions present in a solution prepared by adding the substance to water. **4**

| FORMULA | SYSTEMATIC NAME | OXIDATION NUMBER | PRINCIPAL IONS IN WATER SOLUTION |
|---|---|---|---|
| $\underline{N}O_2$ | | | N/A |
| $\underline{Pb}(CH_3CO_2)_2$ | | | |
| | | | $Mg^{2+}(aq)$; $\underline{Cl}O_4^-(aq)$ |

Write the full electron configuration of the $As^{3+}$ ion.

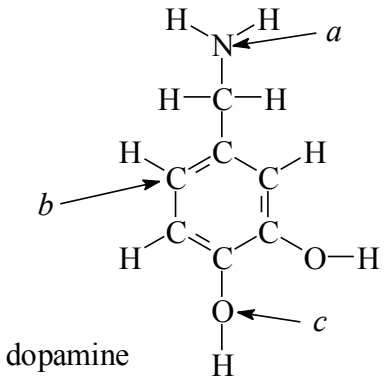
- Draw the Lewis structures, showing all valence electrons for the following species. Indicate which of the species have contributing resonance structures. **5**

| $HCO_3^-$ | COS | $CN^-$ |
|---|---|---|
| Resonance: YES / NO | Resonance: YES / NO | Resonance: YES / NO |

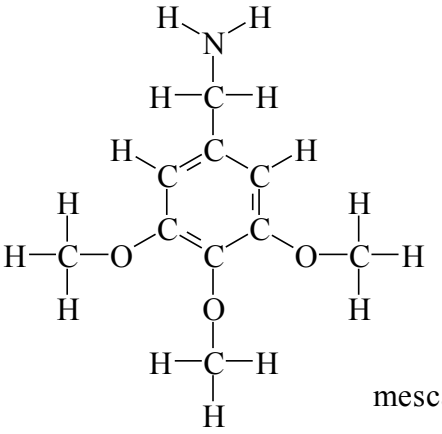
- Name the two intermolecular forces, which best explain the difference in boiling points of 1-propanol ($CH_3CH_2CH_2OH$; bp = 97.2 °C) and 1-propanethiol ($CH_3CH_2CH_2SH$; bp = 67.8 °C). **2**

**Marks 6**

- The structures of dopamine and mescaline are given below.




dopamine



mescaline

Dopamine is involved in the transmission of nerve impulses in the brain. Complete the Lewis structure for dopamine by including all lone pair electrons.

How many π electrons are there in dopamine?

Predict the bond angles at the points labelled *a*, *b*, and *c* in dopamine.

*a*

*b*

*c*

Mescaline is an hallucinogenic compound found in the peyote cactus. Suggest a reason for the ability mescaline to disrupt nerve impulses.

Which compound, dopamine or mescaline, has the higher solubility in water? Give reasons for your answer.