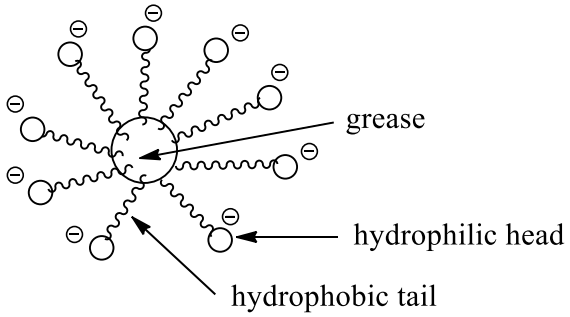
	Marks
• Explain, with the aid of a diagram labelling all the key components, how sodium stearate ($C_{17}H_{35}COONa$) can stabilise long-chain non-polar hydrocarbons ("grease") in water.	3

Sodium stearate dissolves in water to give stearate ions which act as surfactants. They have non-polar (hydrophobic) "tails" that associate with grease and charged, polar (hydrophilic) "heads" that associate with water. This leads to the formation of stable spherical micelles in which the grease molecules are contained within a monolayer of stearate anions with their heads pointing outwards.



- Consider the complex $K_4[Mn(CN)_6]$. Describe and contrast the origin, strength and directionality of the chemical bonds in this compound (a) between C and N; (b) between the manganese and cyanide ions; and (c) between the complex and the potassium counterions.

6

C–N bonds are covalent. They are relatively short, strong and highly directional.

Mn–CN coordination bonds are due to the donation of the lone pair of electrons on C to the Mn^{2+}. These bonds are weaker, longer and less directional than covalent bonds.

$[Mn(CN)_6]^{4-}$ and K^+ are ionically bonded in the solid state due to coulombic attraction between the oppositely charged ions. These bonds are strong but not directional.

• In the spaces provided, explain the meaning of the following terms. You may use an example, equation or diagram where appropriate.	**Marks 2**
(a) covalent bond **A covalent bond describes the situation where an aggregation of 2 or more atoms is stabilised by the delocalisation of electrons among these atoms**	
(b) electronegativity **A measure of the tendency of an atom to attract electrons within a covalent bond.**	
(c) free radical **An atom or molecule with one or more unpaired electrons.**	
(d) band gap **The energy gap between the top of the valence band and the bottom of the conductance bands (the HOMO-LUMO gap) in a solid.**	

- From the list of molecules below, select all the polar molecules and list them from left to right in order of increasing molecular dipole moment. **2**

BF_3, CH_3Cl, CH_3F, CO_2, CF_4, NF_3

The polar molecules are CH_3Cl, CH_3F and NF_3. Although the bonds in the other molecules are polar, the overall molecules are non-polar due to their symmetrical shape.

The molecular dipole moments increase in the order:

NF_3 < CH_3Cl < CH_3F

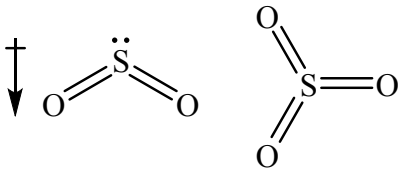
This increase is consistent with the difference in the electronegativity of the atoms: C < N < Cl < F.

	Marks
• Describe two physical properties of liquid or solid water that distinguishes it from 'normal' liquids or solids.	3
The solid is less dense than the liquid. **The density of the liquid can decrease on cooling.** **The melting and boiling points are significantly higher than would be predicted from extrapolation of the other group 16 dihydrides.** **It is capable of dissolving ionic solids to a larger extent than most other liquids.**	
• Describe one consequence of molecular shape involving *non-polar* molecules.	2
The shape of molecules can led to biological specificity, *eg* in smell and in drug action. The shape of molecules also leads to differences in intermolecular forces such as the different boiling points of straight and branched alkanes and the formation of liquid crystal phases in certain molecules.	

- Which molecule in each of the following pairs has the greater dipole moment? Give reasons for your choice. **3**

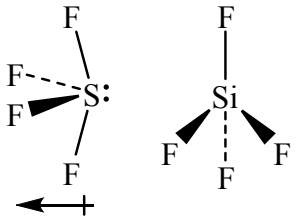
a) SO_2 or SO_3

SO_2 has a larger dipole moment than SO_3.
Both have δ^+ S and δ^- O atoms.
SO_2 is bent leading to the dipole shown.
SO_3 is trigonal planar so that the individual dipoles on the S-O bonds cancel and the molecule has no dipole moment.



b) SiF_4 or SF_4

SF_4 has a larger dipole moment than SiF_4.
Both have δ^- F with δ^+ Si and S respectively.
The unsymmetrical 'see-saw' structure of SF_4 leads to an overall dipole, as shown.
SiF_4 is tetrahedral so that the individual dipoles on the Si-F bonds cancel and the molecule has no dipole moment.



c) H_2S or H_2Te

H_2S has a larger dipole moment than H_2Te.
Both have δ^+ H with δ^- S and Te respectively and are bent leading to overall dipoles, as shown.
S is more electronegative than Te so the partial negative charge on S is considerably bigger leading to a larger dipole moment.