

EXERCISES

Question 1

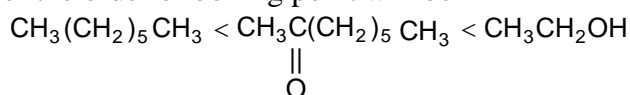
Based on the data in Table 1, predict the boiling points of

- (a) heptane, $\text{CH}_3(\text{CH}_2)_5\text{CH}_3$
 (b) ethanol, $\text{CH}_3\text{CH}_2\text{OH}$
 (c) 2-octanone, $\text{CH}_3\overset{\text{O}}{\underset{\parallel}{\text{C}}}(\text{CH}_2)_5\text{CH}_3$

Answer 1

Note : Table 1 is not available.

However the order of boiling point will be

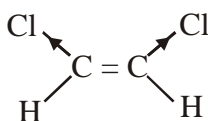


Heptane < 2-octanone < ethanol

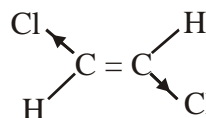
Question 2

Both *cis*-1, 2-dichloroethylene and *trans*-1,2-dichloroethylene have the same molecular formula: $\text{C}_2\text{H}_2\text{Cl}_2$. However, the *cis* compounds has dipole moment, while the *trans* compound does not. One of these species has boiling point of 60.3°C and the other has a boiling point of 47.5°C . Which compound has which boiling point ? Explain your reasoning.

Answer 2



cis-1,2-dichloroethylene
 Unsymmetrical molecule
 As dipole of C–Cl bond
 Does not cancel out by
 other C–Cl bond



trans-1,2-dichloroethylene
 Symmetrical molecule hence no dipole
 moment. Both C–Cl bond are opposite
 to one other, hence effect of one bond
 would be cancelled by other

The *cis*-1,2-dichloroethylene will have higher boiling point i.e 60.3°C . This is because it has dipole moment due to which weak attractive force exist between two such molecules. These weak attractive force will hold molecules together, and thus have less tendency to escape in vapour phase, leading to higher boiling point.

Question 3

Rank each of the following groups of substances in order of increasing boiling point, and explain your reasoning :

- (a) NH_3 , He, CH_3F , CH_4
 (b) CH_3Br , Ne, CH_3OH , CH_3CN
 (c) CH_4 , SiH_4 , GeH_4 , SnH_4

Answer 3

- (a) $\text{He} < \text{CH}_4 < \text{CH}_3\text{F} < \text{NH}_3$
 This is increasing order of attractive force existing among molecules. NH_3 shows hydrogen bonding.
- (b) $\text{Ne} < \text{CH}_3\text{CN} < \text{CH}_3\text{Br} < \text{CH}_3\text{OH}$

increasing molecular mass < Hydrogen bonding

- (c) $\text{CH}_4 < \text{SiH}_4 < \text{GeH}_4 < \text{SnH}_4$
Increasing order of molecular mass and attractive forces.

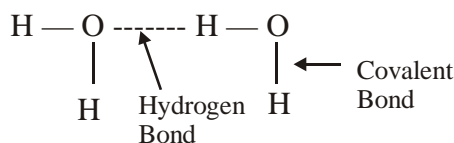
Question 4

Using grammatically correct English sentences, describe the difference between the hydrogen bond between two water molecules and O–H bond in a particular water molecule.

Answer 4

The bond between O and H atom in a molecule of H_2O is covalent in nature, while hydrogen bonding between H atom of one molecule and O atom of other molecule is weak electrostatic attraction in nature.

Covalent bonds formed due to sharing of electrons are stronger bond than weak electrostatic forces existing in hydrogen bonding.

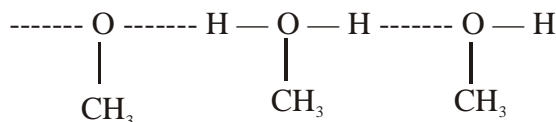


Question 5

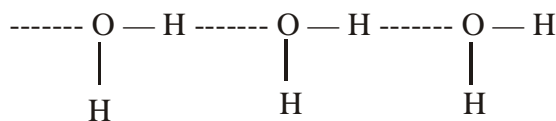
Fluoromethane, CH_3F , and methanol, CH_3OH , have approximately the same molecular weight. However, the boiling point of CH_3OH is 65.15°C , whereas the boiling point of CH_3F is almost 100 degrees lower, -78.4°C . Explain.

Answer 5

Fluoromethane, CH_3F , and methanol, CH_3OH , have approximately the same molecular weight but boiling point of CH_3OH is greater (65.15°C) than boiling point of CH_3F (-78.4°C) because methanol forms hydrogen bond but CH_3F does not. Stronger bonding interaction among CH_3OH , makes it less volatile and increase its boiling point.



Similar to hydrogen bonding in H_2O .



PROBLEMS

Question 1

In each of the following groups of substances, indicate which has the highest boiling point and explain your answer

- (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$; $\text{CH}_3\text{OCH}_2\text{CH}_3$; $\text{CH}_3\text{CH}_2\text{CH}_2\text{F}$; $\text{N}(\text{CH}_3)_3$; $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
 (b) HCl ; H_3CCF_3 ; H_2O ; CCl_4 ; NaCl
 (c) LiF ; O_2 ; H_2O ; CaO ; I_2

Answer 1

- (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$. It has $-\text{NH}_2$ group which is capable of forming hydrogen bond.
 (b) NaCl . Because it is ionic compound.
 (c) LiF . It is ionic compound and have highest Lattice energy.

Question 2

Which of the following liquids does not exhibit hydrogen bonding ?

- H_2O ; CH_3CCH_3 ; CH_3COH ; CH_3CCH_3 ; NaCl
 $\begin{array}{c} \parallel \\ \text{O} \end{array}$ $\begin{array}{c} \parallel \\ \text{O} \end{array}$ $\begin{array}{c} \parallel \\ \text{O} \end{array}$

All of these compounds have hydrogen bonding.

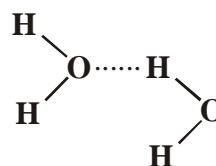
Answer 2

All of these compound have hydrogen bonding.

Question 3

Which is the hardest to break ?

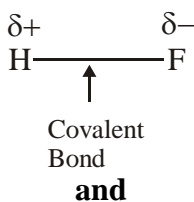
- (a) the H–O bond in water
 (b) the hydrogen bond represented by “.....” in water.



- (c) the H–F bond in hydrogen fluoride
 (d) the H–C bond in methane
 (e) the H–N bond in ammonia

Answer 3 (C)

The H–F bond in hydrogen fluoride, because it is polar covalent bond having largest magnitude of polarity than other mentioned molecules.



Electrostatic attraction due to partial positive ($\delta+$) and partial negative ($\delta-$) charge.