

CHAPTER SEVEN

Intermolecular Forces

7.51 Give an example for each type of intermolecular forces. (a) dipole-dipole interaction, (b) dipole-induced dipole interaction, (c) ion-dipole interaction, (d) dispersion forces, (e) van der Waals forces

7.52 Explain the term “polarizability.” What kind of molecules tend to have high polarizabilities? What is the relationship between polarizability and intermolecular forces?

7.53 Explain the difference between a temporary dipole moment and the permanent dipole moment.

7.54 Give some evidence that all atoms and molecules exert attractive forces on one another.

7.55 What physical properties should you consider in comparing the strength of intermolecular forces in solids and in liquids?

7.56 Which elements can take part in hydrogen bonding? Why is hydrogen unique in this kind of interaction?

7.57 The compounds Br_2 and ICl have the same number of electrons, yet Br_2 melts at -7.2°C and ICl melts at 27.2°C . Explain.

7.58 If you lived in Alaska, which of the following natural gases would you keep in an outdoor storage tank in winter? Explain why. methane (CH_4), propane (C_3H_8), or butane (C_4H_{10})

7.59 The binary hydrogen compounds of the Group 4A elements and their boiling points are: CH_4 , -162°C ; SiH_4 , -112°C ; GeH_4 , -88°C ; and SnH_4 , -52°C . Explain the increase in boiling points from CH_4 to SnH_4 .

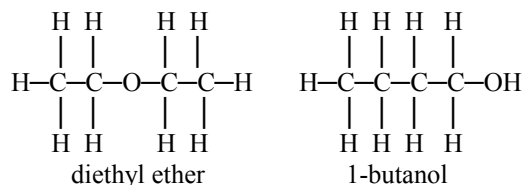
7.60 List the types of intermolecular forces that exist between molecules (or basic units) in each of the following species: (a) benzene (C_6H_6), (b) CH_3Cl , (c) PF_3 , (d) NaCl , (e) CS_2 .

7.61 Ammonia is both a donor and an acceptor of hydrogen in hydrogen-bond formation. Draw a diagram showing the hydrogen bonding of an ammonia molecule with two other ammonia molecules.

7.62 Which of the following species are capable of hydrogen-bonding among themselves? (a) C_2H_6 , (b) HI , (c) KF , (d) BeH_2 , (e) CH_3COOH

7.63 Arrange the following in order of increasing boiling point: RbF , CO_2 , CH_3OH , CH_3Br . Explain your reasoning.

7.64 Diethyl ether has a boiling point of 34.5°C , and 1-butanol has a boiling point of 117°C :



Both of these compounds have the same numbers and types of atoms. Explain the difference in their boiling points.

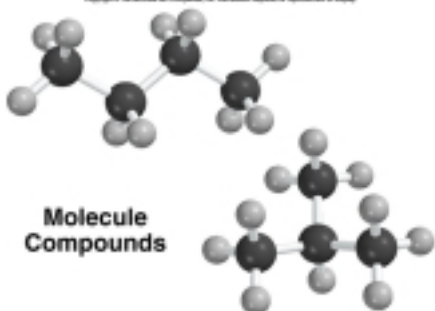
7.65 Which member of each of the following pairs of substances would you expect to have a higher boiling point? (a) O_2 and Cl_2 , (b) SO_2 and CO_2 , (c) HF and HI

7.66 Which substance in each of the following pairs would you expect to have the higher boiling point? Explain why. (a) Ne or Xe , (b) CO_2 or CS_2 , (c) CH_4 or Cl_2 , (d) F_2 or LiF , (e) NH_3 or PH_3

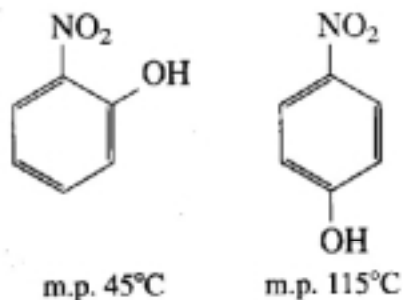
7.67 Explain in terms of intermolecular forces why (a) NH_3 has a higher boiling point than CH_4 and (b) KCl has a higher melting point than I_2 .

7.68 What kind of attractive forces must be overcome in order to (a) melt ice, (b) boil molecular bromine, (c) melt solid iodine, and (d) dissociate F_2 into F atoms?

7.69 The following compounds have the same molecular formulas (C_4H_{10}). Which one would you expect to have a higher boiling point?



7.70 Explain the difference in the melting points of the following compounds:



(Hint: Only one of the two can form intramolecular hydrogen bonds.)

7.71 Name the kinds of attractive forces that must be overcome in order to (a) boil liquid ammonia, (b) melt solid phosphorus (P_4), (c) dissolve CsI in liquid HF, (d) melt potassium metal.

7.72 Which of the following properties indicates very strong intermolecular forces in a liquid? (a) very low surface tension, (b) very low critical temperature, (c) very low boiling point, (d) very low vapor pressure

7.73 At -35°C , liquid HI has a higher vapor pressure than liquid HF. Explain.

7.74 Which of the following statements are false? (a) Dipole-dipole interactions between molecules are greatest if the molecules possess only temporary dipole moments. (b) All compounds containing hydrogen atoms can participate in hydrogen-bond formation. (c) Dispersion forces exist between all atoms, molecules, and ions. (d) The extent of

ion-induced dipole interaction depends only on the charge on the ion.

7.75 Select the substance in each pair that should have the higher boiling point. In each case identify the principal intermolecular forces involved and account briefly for your choice. (a) K_2S or $(CH_3)_3N$, (b) Br_2 or $CH_3CH_2CH_2CH_3$

7.76 Under the same conditions of temperature and density, which of the following gases would you expect to behave less ideally: CH_4 , SO_2 ? Explain.

7.77 The fluorides of the second-period elements and their melting points are: LiF, 845°C ; BeF_2 , 800°C ; BF_3 , -126.7°C ; CF_4 , -184°C ; NF_3 , -206.6°C ; OF_2 , -223.8°C ; F_2 , -219.6°C . Classify the type(s) of intermolecular forces present in each compound.

7.78 If water were a linear molecule, (a) would it still be polar, and (b) would the water molecules still be able to form hydrogen bonds with one another?

7.79 Use the concept of intermolecular forces to explain why the far end of a walking cane rises when one raises the handle.