

11.1

a) This diagram best represents a liquid

b) Because its particles are grouped closely together, but are not in an ordered structure. As such, it is not an orderly solid or a low density gas.

11.8

a) Propanol

b) I expect Ethyl methyl ether to have a larger dipole moment

c) Propanol has the higher BP of 97.2°C . Ethyl methyl ether has the lower BP of 10.8°C .

11.11

a) Molecular Disorder = solid < liquid < gas

b) IMF's = gas < liquid < solid

c) Most Easily Compressed = solid < liquid < gas

11.12

a) As the average kinetic energy of the particles within a substance increase the attraction between these particles decreases.

b) As the temperature of a solid increases, the molecules move more rapidly, until the structure of the solid collapses and it melts. Then the liquid particles accelerate until the IMF's fail and the liquid becomes a gas.

c) If you pressurize a gas to extreme pressures, the molecules will move so close together that their IMF's will cause the gas to liquify.

11.20

- a) CH_3OH exhibits hydrogen bonding, whereas CH_3SH does not exhibit stronger hydrogen bonds, but weaker dipole/dipole interactions. As a result, CH_3OH boils at a higher temperature.
- b) Xe is more massive than Ar, making it more polarizable. As such, its stronger induced dipoles hold it together as a liquid at room temp.
- c) Cl_2 molecules are more elongated than Kr atoms, making it more polarizable. As such, its stronger induced dipoles cause it to have a higher boiling point.
- d) The presence of the highly electronegative O atom in acetone makes it more polar than 2-methylpropane.

11.25 In comparison to 2-methylpropane, butane is a more elongated molecule, allowing it to exhibit greater induced dipoles, causing it to have a higher boiling point than 2-methylpropane.

11.29a) Replacing a hydrogen bonded to an oxygen with a $-\text{CH}_3$ group eliminates the potential for hydrogen bonding, decreasing the IMF's exhibited by the molecule.

b) $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_3$ is a larger molecule, making it more polarizable. This causes stronger induced dipoles forces and a higher boiling point.

11.30

a) Propane: Induced Dipole

n-butane: Induce Dipole

b) Diethyl ether: Dipole/Dipole & Induced Dipole

1-butanol: Hydrogen Bonding & Induced Dipole

c) SO_2 : Dipole/Dipole & Induced Dipole

SO_3 : Induce Dipole

d) **Cl_2CO** : Dipole/Dipole & Induced Dipole

H_2CO : Dipole/Dipole & Induced Dipole

11.35

- a) As the temperature of a liquid increases the molecules move faster, moving past each other more easily and weakening the IMF's between the molecules. This reduces the surface tension of the liquid and makes it less viscous.
- b) Liquids with high surface tensions have strong IMF's. These strong IMF's cause the liquids to also have high viscosities.
- c) Both high surface tension and high viscosity can indicate strong IMF's. As such, we would expect them to trend together.

11.37

- a) Diagram ii the adhesive forces between the surface and the liquid exceed the cohesive forces within the liquid.
- b) Diagram i represents water on a nonpolar surface.
- c) Diagram ii represents water on a polar surface.

11.39

a) All three molecules exhibit hydrogen bonding, dipole/dipole forces and induced dipoles. The reason for the increase in BP, surface tension and viscosity is an increase in mass, causing their induced dipole forces to strengthen.

b) While propanol and ethylene glycol have similar masses, ethylene has two -OH groups, compared with the single -OH group on propanol. The additional -OH group allows for stronger hydrogen bonding and a significantly higher viscosity.

c) Water has the highest surface tension because its molecules exhibit strong hydrogen bonds and are small, allowing them to come close together. Water's viscosity is low because these small molecules move past each other easily.

11.41

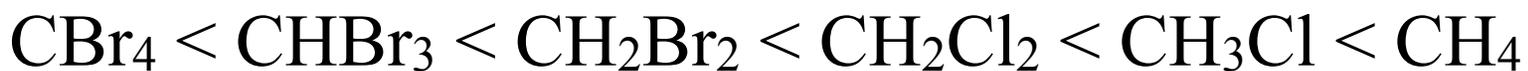
- a) melting - endothermic
- b) evaporation - endothermic
- c) freezing - exothermic (it gives up heat to the cold class)
- d) condensation - exothermic

11.51

- a) Volume has no effect on vapor pressure
- b) surface area has no effect on vapor pressure.
- c) IMF's and vapor pressure are inversely related.
- d) Temperature and vapor pressure are directly related.
- e) Density and vapor pressure are inversely related. As density increases, the IMF's of the liquid strengthen, decreasing vapor pressure (11.49c)

11.53

a) Volatility is inversely related to IMF strength. Placing these molecules in decreasing order of IMF strength places them in order of increasing volatility:



b) Since highly volatile liquids have low boiling points, the order would be reversed in order of increasing boiling point.

11.54

a) False b) True c) False d) False

11.60

- a) Solids and liquids have the most similar densities.
- b) The melting curve is least affected by changes in pressure
- c) Because sublimation and vaporization both involve the breaking of IMF's we would expect these curves to be more impacted by pressure change than the melting process in which IMF's are not broken.

11.63

- a) $\approx 25\text{K}$
- b) pressures below about $.5\text{atm}$
- c) At room temp (298K) neon cannot liquify.

11.65

- a) Referencing figure 11.30, the conditions on Titan are close to the solid/liquid boundary for methane, leading us to believe it will exist as a liquid and a solid.
- b) As we move away from the surface of Titan, the decreasing pressure would cause methane to likely exist as a gas.