

CH 301 Fall 2005 Worksheet 9: Intermolecular Forces

1. What is the major disagreement between the kinetic molecular theory and Coulomb's Law?

Coulomb's predict attraction based on charge polarization

2. Which of the following gases would deviate the least from the ideal gas equation. Which one would deviate the most? Explain your answers.

H₂ N₂ HF

Deviates least: H₂ Explain: *smallest, least inst. dipole*

Deviates most: HF Explain: *strongest IMF from H bonds*

3. True and false time. Be able to explain your answer.

(a) Hydrogen bonds are sometimes stronger than covalent bonds. *20 kJ 400 kJ*

(b) A dipole moment in a molecule is caused by a difference in electron density.

(c) An ion-ion interaction involves the *donation* sharing of electrons between nuclei.

(d) In a series of ionic compounds, the compound with the largest charge density in the ions will have the highest melting point..

(e) Hydrogen bonds can exist between a hydrogen atom and any other element

need high EN element like N, O, F, Cl

(f) London forces in a compound can be large enough to create solid materials at room temperature

yes, if compound is large enough

(g) Water rises in a capillary tube because it is attracted to the glass.

yes, the H is δ^+ is H₂O and is attracted to δ^- of O in SiO₂

(h) Instantaneous dipoles exist in ALL compounds.

all comds have e⁻ that move around.

4. Classify each of the following interactions as a covalent bond, ion-ion interaction, hydrogen bonding, permanent dipole, or London forces:

(a) The interaction between potassium and bromine in KBr *ionic*

(b) The interaction responsible for water's surface tension *H bond*

(c) The attraction between two carbons in a hydrocarbon *covalent bond*

(d) The interaction between one molecule of CH₃F and another molecule of CH₃F *dipole dipole (permanent)*

(e) The attraction of the electrons of one Ar atom for another Ar atom's nucleus *inst. dipole (London)*

5. If you spilled a few drops of ether on a lab bench, would you expect it to form beads of liquid on the surface, or spread out evenly? Why? What about water?

ether is fairly nonpolar so little surface tension, spreads out
 H₂O beads up because H bond make high surface tension

6. It takes longer to cook spaghetti at high altitude. Why?

high altitude, lower atm pressure, lower b.p. for H₂O

7. For each of the solution properties, explain the relationship to increasing intermolecular forces.

(a) Viscosity

(b) Capillary Action

(c) Surface Tension

(d) Vapor Pressure

(e) Tendency to Evaporate

} IMF ↑ all 3 properties ↑

IMF ↑ vapor pressure ↓

IMF ↑ evap ↓

8. Predict the order of increasing capillary action for the following:

H₂S; H₂O; CH₄; H₂; KBr

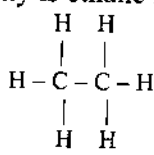
H₂ < CH₄ < H₂S < H₂O < KBr

9. Put the following compounds in order from lowest boiling point to highest boiling point and justify your answer.

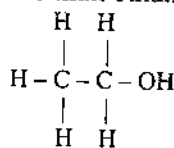
CH₄; C₄H₁₀; C₂H₆; C₃H₈; C₅H₁₂

CH₄ < C₂H₆ < C₃H₈ < C₄H₁₀ < C₅H₁₂

10. Why is ethane less viscous than ethanol?



Ethane



Ethanol

↑ increasing # of e⁻
 ethane has inst. dipoles only
 ethanol has H-bonding which is stronger

11. Put the following compounds in order from the lowest melting point to highest melting point:

CaO, K₂O glass (SiO₂), H₂O, CHCl₃, C₂H₆, Ar, He

He < C₂H₆ < Ar < CHCl₃ < H₂O < K₂O < CaO < glass

12. For each solid classify its bonds as ionic, covalent, or metallic:

(a) KF

ionic

(b) CsI

ionic

(c) Ni

metallic

(d) C₆H₆

molecular

(e) H₂O

molecular