

CH 301 Fall 2008 Worksheet 10: Intermolecular Forces Answer Key

1. What is the major flaw with kinetic molecular theory that makes it unable to explain condensed matter?
- a. **KMT assumes that there are no attractive forces between molecules and that consequently every molecule is a gas that when it collides with another molecule undergoes a perfectly elastic collision. In fact attractive forces exist in every kind of molecule and hence all molecules, at sufficiently low temperature become liquids and solids.**

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 size and smallest instantaneous dipoles.**

Deviate Most: **HF**

Explain: **although N₂ is the largest of the gases, it has only instantaneous dipoles whereas HF has strong H-bonding**

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

T F (a) Hydrogen bonds are sometimes stronger than covalent bonds—False, the strongest hydrogen bonds are still an order of magnitude smaller than covalent bonds.

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

T F (c) An ion-ion interaction involves the sharing of electrons between nuclei—False, donation of electrons

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

T F (e) Hydrogen bonds can exist between a hydrogen atom and any other elements. False
False Need to be bonded to strongly EN elements such as N,O, F

T F (f) London forces in a compound can be large enough to create solid materials at room temperature
True, the larger the molecule the more the electrons to contribute instantaneous dipoles.

T F (g) Water rises in a capillary tube because of strong adhesive forces attracted to the glass walls.
True, the δ^+ of H₂O is attracted to δ^- of the O in the SiO₂ of the glass walls.

T F (h) Instantaneous dipoles exist in ALL compounds.
True, all compounds have e⁻ that can contribute to instantaneous dipoles.

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 hydrocarbon (**covalent bond**)

d. The interaction between one molecule of CH₃F to another molecule of CH₃F
(**dipole-dipole**)

e. The attraction of the electrons of an Ar atom to a CH₃F
(**inst. dipole-dipole**)

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 has only a modest dipole moment so little surface tension is created so the molecules do not bead up-- H₂O beads up because of H-bond which contribute to high surface tension.

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

At high altitude there is lower atmospheric pressure so lower temperature needed to boil—this means more time is needed to cook spaghetti.

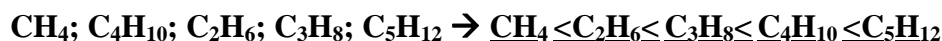
7. For each of the solution properties, explain the relationship to increase intermolecular forces.

- | | |
|--------------------------|-------------------------|
| a. Viscosity | IFM ↑ viscosity ↑ |
| b. Capillary Action | IFM ↑ cap. action ↑ |
| c. Surface Tension | IFM ↑ surface tension ↑ |
| d. Vapor Pressure | IFM ↑ vapor pressure ↓ |
| e. Tendency of Evaporate | IFM ↑ evaporation ↓ |

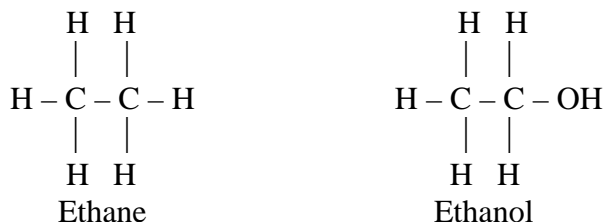
8. Predict the order of increasing capillary action for the following:



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



10. Why is ethane less viscous than ethanol?



Ethane has instantaneous dipole only; ethanol has H-bonding which is stronger.

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



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

- KF **(Ionic)**
- CsI **(Ionic)**
- Ni **(Metallic)**
- C₆H₂ **(Molecular)**
- H₂O **(Molecular)**