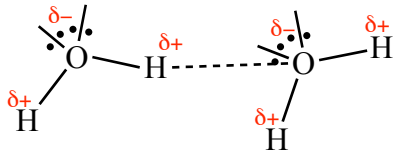
WKS
Intermolecular Forces, MP & BP

Name Answer Key _____
Period _____ ***Date*** _____

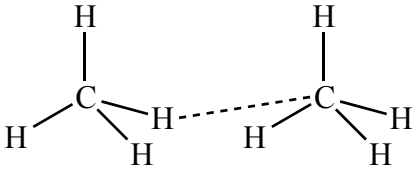
1) Review of Intermolecular forces:
   a) What type of intermolecular bond attract two nonpolar covalent molecules? Dispersion
   b) What two types of intermolecular bonds could attract two polar covalent molecules?
      H-Bonding _____ Dipole-Dipole _____
   c) How do you know if a molecule can do hydrogen bonding instead of just dipole-dipole?
      It contains an H atom bonded to an N, O, or F atom.

2) Look at the diagrams below. Put in any significant partial charges. An intermolecular force has been shown with dots for each situation. Determine what type of intermolecular force is shown in each case.

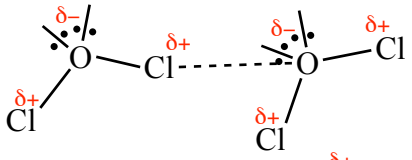
Intermolecular force
(dispersion, dipole-dipole, H-bonding)

a) 

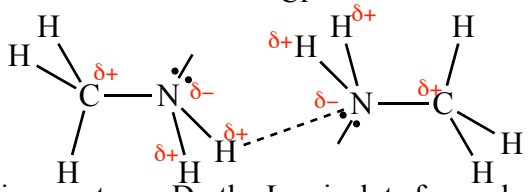
H-Bonding

b) 

Dispersion

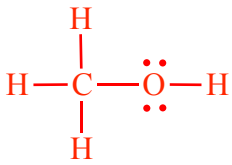
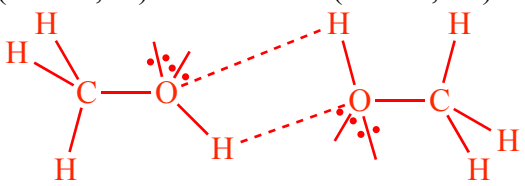
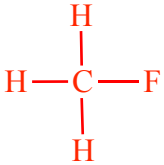
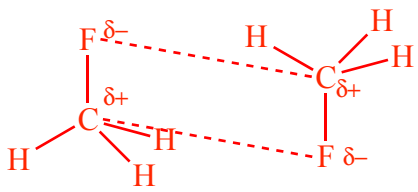
c) 

Dipole-Dipole

d) 

H-Bonding

3) Now, it is your turn. Do the Lewis dots for each of these molecules, draw the 3D shape and put in partial charges. Then, draw the same 3D molecule again with partial charges. Draw **dots** between the molecules to show an intermolecular attraction and determine the type of intermolecular force.

	Lewis dot	3-D shape (with δ^-, δ^+)	Another 3D shape (with δ^-, δ^+)	Intermolecular force
a) CH_3OH				H-Bonding
b) CH_3F				Dipole-Dipole

4) What type of bond must break when a molecular substance boils? Intramolecular or intermolecular? Inter

5) Thus, the strength of intermolecular bonds directly affects the temperatures at which substances melt and boil. *(The strengths affect boiling points and melting points.)*

a) Rank the three intermolecular forces from weakest to strongest.

weakest Dispersion Dipole-Dipole H-Bonding *strongest*

b) The stronger the intermolecular forces, the **(more, less)** heat is needed to break those attractions.

c) The stronger the intermolecular forces, the **(lower, higher)** the melting point and boiling point.

6) Besides molecular (covalent) substances, there are also metallic and ionic substances.

a) What types of species are attracted in metallic substances? Metal cations & delocalized electrons

b) Thus, when metallic substances are melted or boiled,attractions between **(partial, full)** charges are broken.

c) What type of species are attracted in ionic substances? Metal cations & nonmetal anions

d) Thus, when an ionic substances is melted or boiled, attractions between **(partial full)** charges are broken.

e) When a molecular substance is melted or boiled, attractions between **(partial, full)** charges are broken.

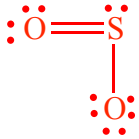
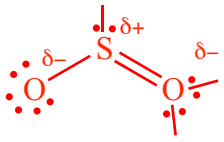
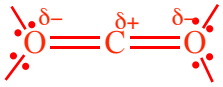
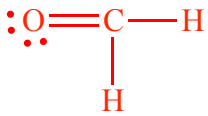
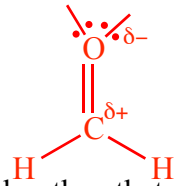
7) *From your answers in the previous question above, you should now realize that ionic and metallic bonds are more difficult to break than intermolecular forces. Thus, ionic and metallic substances have higher melting points and boiling points (b/c has stronger attractions) than molecular (covalent) substances.*

For each substance below, label whether each is **C**ovalent, **I**onic or **M**etallic. Then, **circle** the substance in each pair with the higher boiling point.

a) CH_4 or $CaCl_2$ b) Fe or H_2O c) NH_3 or NaCl

C, I, M→ C I M C C I

8) Draw the Lewis Dots and 3D structures of the following molecular substances. Put in partial charges and then what type of intermolecular bonding each molecule can do.

	Lewis Dot	3D Shape	Intermolecular bonding
a) SO_2			Dipole-Dipole
b) CO_2			Dispersion
c) CH_2O			Dipole-Dipole

9) Explain why the boiling point SO_2 is higher than that of CO_2. (Refer to structures on front or above.)
SO_2 contains stronger dipole-dipole forces while CO_2 only contains dispersion forces, which are weaker and take less energy to break.

10) Explain why the boiling point of H_2O is higher than that of CH_2O. (Refer to structures on front or above.)
H_2O exhibits stronger H-bonding, which takes more energy to break than the dipole-dipole forces of CH_2O

11) Use your own logic to predict which substance below has the higher boiling point? CH_3CH_3 Explain.

a) CH_4 CH_3CH_3 contains more electrons, so is more polarizable and has stronger dispersion forces.

b) CH_3CH_3