AP Chem - Unit 7 Key

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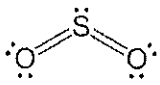
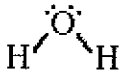
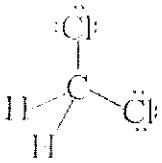
WKST: Intermolecular Force Worksheet Key

1. Draw the following substances. Then, identify **the strongest** intermolecular force present in pure samples of the following substances:

SO_2 H_2O CH_2Cl_2

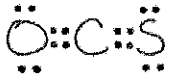


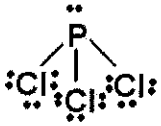


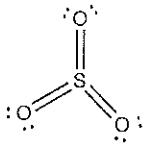


dipole-dipole forces hydrogen bonds dipole-dipole forces

SCO PCl_3 SO_3







dipole-dipole forces dipole-dipole forces London dispersion forces

2. Identify the strongest intermolecular force operating in the condensed phases of the following substances. Fully explain how you determined this.

a. Cl_2 London dispersion forces The Cl-Cl bond is nonpolar so the molecule is nonpolar. Non polar molecules have only London dispersion forces operating in the substance.	b. CO Dipole-dipole forces The C-O bond is polar so the molecule is polar. Polar molecules have dipole-dipole forces. They also have London dispersion forces, but dipole-dipole forces are stronger.
c. SO_2 Dipole-dipole forces SO_2 is a bent, polar molecule. The strongest intermolecular force in a polar molecule is the dipole-dipole force	d. CH_2Cl_2 Dipole-dipole forces The strongest intermolecular force in a polar molecule that cannot form hydrogen bonds is the dipole-dipole force
e. HF Hydrogen bonding forces Molecules that have hydrogen attached to an O, N, or F can form hydrogen bonds. These are the strongest of the intermolecular forces.	g. CH_3-O-CH_3 Dipole-dipole forces The hydrogen atoms are not bonded to the oxygen, so this molecule cannot form hydrogen bonds. It is polar, so it will have dipole-dipole forces.

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3. Based on the intermolecular forces present, predict the relative boiling points of each of the substances below. Arrange each series of substances in order of increasing boiling point. State your reasons for the order you use (identify the forces and explain how they affect the boiling point).

a. dimethyl ether (CH_3OCH_3), ethanol (CH_3CH_2OH), and propane ($CH_3CH_2CH_3$)

lowest bp: propane ($CH_3CH_2CH_3$) < dimethyl ether (CH_3OCH_3)< ethanol (CH_3CH_2OH) highest bp

Dimethyl ether cannot form hydrogen bonds (no O-H bond), but is polar and has dipole-dipole forces. Ethanol can form hydrogen bonds. propane is nonpolar, so it has only London dispersion forces. The boiling point increases as the strength of the intermolecular forces increase:

London dispersion < dipole-dipole forces < hydrogen bonds

[All have similar molar masses: 46.07g/mol, 46.07g/mol and 44.09g/mol respectively.]

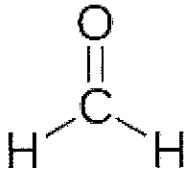
b. Br_2, Cl_2, I_2

lowest bp: $Cl_2 < Br_2 < I_2$ highest bp

All are nonpolar molecules so only London dispersion forces are present. London dispersion forces get stronger as molar mass increases.

4. Circle ***all*** of the intermolecular forces that exist between molecules for the following samples:

A. water: dipole, hydrogen
B. methane (CH_4): London dispersion
C. CH_2O: dipole



D. SF_4: dipole

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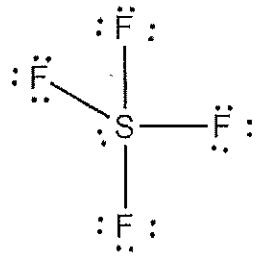

E. CH_2F_2: dipole

5. Rank the following substances in terms of increasing boiling points: water, CH_2O, methane, CO_2

methane, CO_2, CH_2O, water