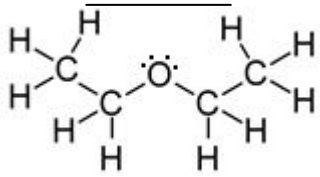
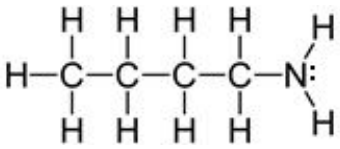
Unit 6 Test: IMFs & Polarity Name _____80 points_____ Block ____

1. The diagrams below represent the chemical structures of two organic molecules.

Chemical X



Chemical Y



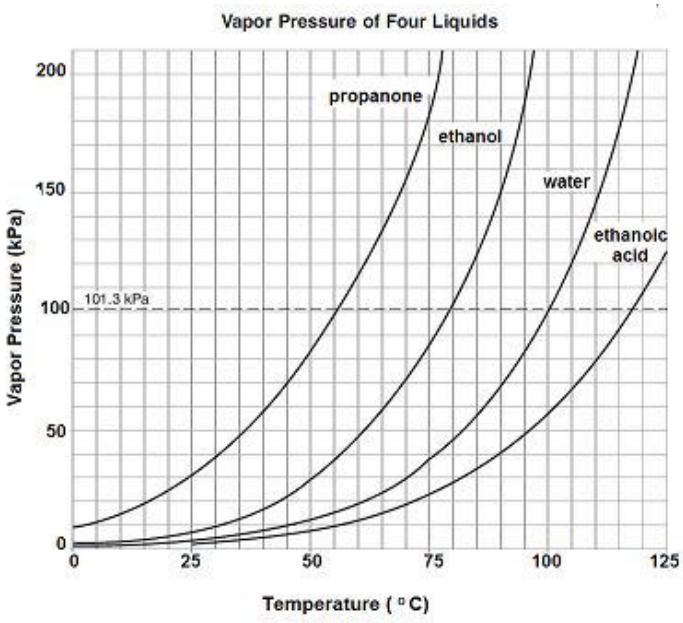
Chemical	Molar Mass	Boiling Point	Solubility in Water
X	74.12 g/mol	34.6 °C	low
Y	73.139 g/mol	78.0 °C	high

(a) Which intermolecular forces exist in Chemical X? London forces and dipole –dipole (2pts)

(b) Which intermolecular forces exist in Chemical Y? London forces and hydrogen bonding (2 pts)

(c) Which structure has stronger intermolecular forces? Explain using **all** evidence from above.
Chemical Y has stronger forces because it contains hydrogen bonding (1 pt), it is more soluble in water (1 pt), and it has a higher boiling point (1 pt).

2. Use the graph to the right to answer these questions:



(a) The normal boiling point of each liquid is:

Propanone: 55 °C (1 pt)

Ethanol: 80 °C (1 pt)

Water: 100 °C (1 pt)

Ethanoic acid: 117-118 °C (1 pt)

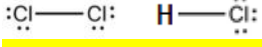
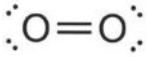
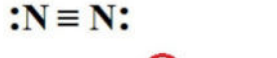
(b) The vapor pressure of ethanol at 90 °C is 150 kPa. (1 pt)

(c) Does propanone have stronger or weaker intermolecular forces than ethanoic acid? Explain. Weaker forces (1 pt)

Propanone has weaker forces because it has a lower boiling point. (1 pt)

3. Using diatomic molecules, draw examples of single bonds, double bonds, and triple bonds.

ALL STRUCTURES MUST ONLY CONTAIN 2 ATOMS.

Single bonds (1 pt)	Double bonds (1 pt)	Triple bonds (1 pt)
 H, F, Br, or I can be substituted.	 Carbon dioxide is wrong because it has 3 atoms!	 

4. During the Unit 6 Lab, Station 7 required you to use a balloon to induce a charge on pieces of rice. Compare the molecular structure of a nonpolar molecule before and after a charge is induced.

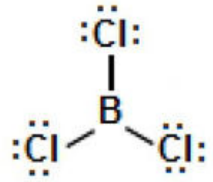
Nonpolar molecules have evenly distributed electrical charges. (1 pt) After a charge is induced, the charges are redistributed to create a temporary dipole. (1 pt)

5. Which of the following does not exhibit hydrogen bonding and why? CH_3COOH, CH_3OH, CH_2O, H_2O

CH_2O does not have hydrogen bonding because the oxygen is only bonded to a carbon atom – not a hydrogen atom. (2pts)

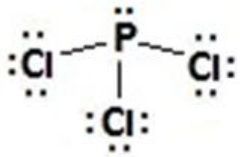
6. Draw the following molecules, list their VSEPR shapes, bond angles, and which intermolecular forces they possess. (Note: More than one shape, bond angle, and IMF may be present in each molecule.)

boron trichloride



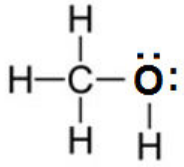
B: trigonal planar 120
London forcces

phosphorus trichloride



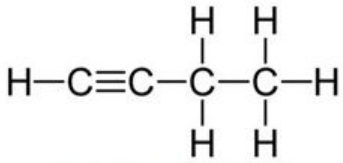
P: trigonal pyramidal 107
Dipole - Dipole

methanol



C: tetrahedral 109 London
O: bent 105 Hydrogen bonding

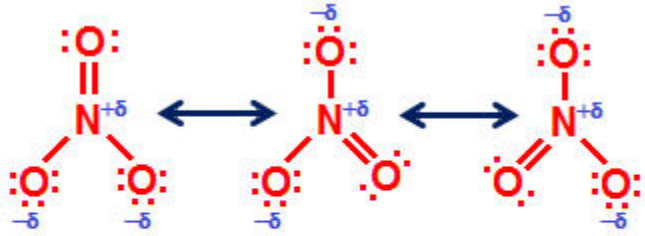
butyne



C (1 and 2): linear 180 London
C (3 and 4): tetrahedral 109.5 London

(1 pt) for drawing (1 pt) bond shape (1 pt) bond angle (1 pt) for intermolecular force

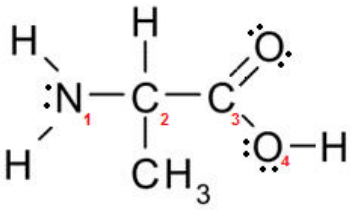
7. Show three possible resonance structures for the nitrate ion. List the bond angles, shape, and IMF.



Nitrate ion
120° Trigonal Planar
ion - ion attraction

(1 pt for each resonance – must have correct number of oxygen atoms)
(1 pt for shape, 1 pt for angle, 1 pt for intermolecular force)

8. Label all the bond angles, shapes, and intermolecular forces present in the molecule below.



N_1: 107°, pyramidal, hydrogen bonding
C_2: 109.5°, tetrahedral, London
C_3: 120°, planar, dipole – dipole
C_4: 105°, bent, hydrogen bonding
All worth 1 pt each

9. Use the data table below to answer the following questions.

Liquid Compounds	Normal Boiling Points (°C)
HF	19.4
CH_3Cl	–24.2
CH_3F	–78.6
HCl	–83.7

(a) All of the compounds in the data table are polar, which means they have similar attractive forces. What accounts for the differences in boiling point? HF has the highest BP because of hydrogen bonding. (1 pt) CH_3Cl, CH_3F, HCl are all dipoles, but CH3Cl has higher mass which requires more energy to boil. So they are listed in order of mass. (1 pt)

(b) Would you expect a molecule of CH_3Br to have a higher or lower normal boiling point than CH_3Cl?

Explain. Higher (1 pt) Bromine is a larger atom and has more mass (1 pt)

10. Sort the following from weakest to strongest based on intermolecular forces: CO_3^{-2}, O_2, H_2O, CO_2
Explain your reasoning. $O_2 < CO_2 < H_2O < CO_3^{-2}$ (1 pt for each in the proper order) O_2 and CO_2 are both London (1 pt), but O_2 has smaller mass, (1 pt) H_2O has hydrogen bonding (1 pt), CO_3^{-2} is capable of ion-ion attraction (1 pt)

11. Explain how hydrogen bonding occurs. Give examples of three molecules that form hydrogen bonds.
Hydrogen boding occurs when an unshielded hydrogen nucleus (1 pt) is attracted to strong electronegative atom (1 pt). It only occurs with Nitrogen, Oxygen, and Flourine. (1 pt) Examples are ammonia (NH_3) (1 pt), water (H_2O) (1 pt), and hydrogen fluoride (HF) (1 pt).

12. Give an example of a pharmaceutical molecule and explain how it is used.
Any of the following are acceptable: (1 pt for chemical; 1 point for use)

Aspirin for aches and pains and blood pressure; vitamins to help you grow; or insulin for diabetes

WARNING: Any other molecules must be classified as organic hydrocarbons. Hydrogen peroxide does not count since it does not contain carbon!

13. Give an example of a natural polymer and explain which intermolecular forces hold it together.
DNA, RNA, Proteins, or Amino Acids (1 pt) held together by hydrogen bonding (1 pt)