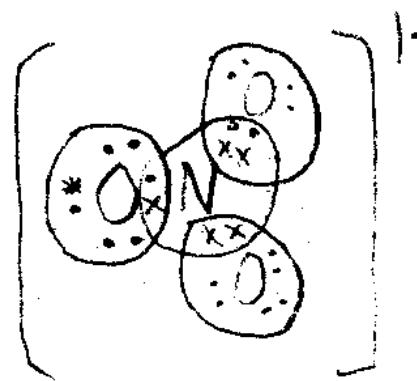
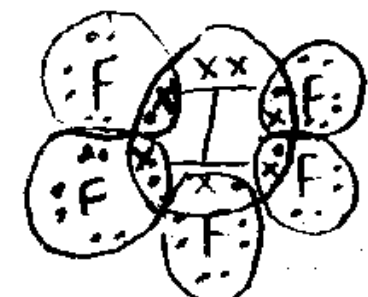
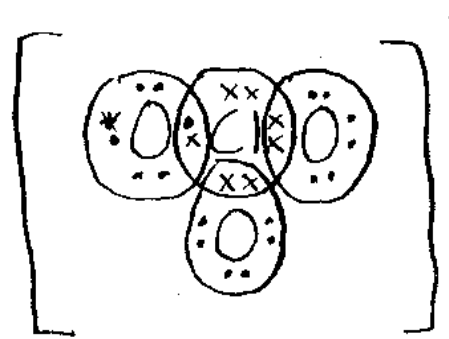


SCH 4U Unit Test Forces and Molecular Properties

1. Fill in each table as done on the assignment. Including the oxidation state of the central atom:

NO_3^{1-} 	total # of e^- pairs	4
	σ bonding pairs	3
	lone pairs	0
	π bonding pairs	1
	base shape	trigonal planar
	actual shape	trigonal planar
oxidation state of N \rightarrow 5+	approx. bond angles	120°

IF_5 	total # of e^- pairs	6
	σ bonding pairs	5
	lone pairs	1
	π bonding pairs	0
	base shape	octahedral
	actual shape	square based pyramid
oxidation state of I \rightarrow 5+	approx. bond angles	$< 90^\circ$

ClO_3^{1-} 	total # of e^- pairs	4
	σ bonding pairs	3
	lone pairs	1
	π bonding pairs	0
	base shape	tetrahedral
	actual shape	pyramidal
ox. state of Cl \rightarrow 5+	approx. bond angles	$< 109.5^\circ$

2. Classify each of the following formula according to type of forces by placing each formula in the correct place in the table:

- | | |
|--|---|
| - SiCl ₄ (silicon(IV) chloride) | - K ₂ O (potassium oxide) |
| - HCOOH (methanoic acid) | - (NH ₄) ₂ SO ₄ (ammonium sulphate) |
| - C ₂ H ₅ OH (ethyl alcohol) | - Li ₃ N(lithium nitride) |
| - C _n (diamond) | - NH ₄ NO ₃ (ammonium nitrate) |
| - CO ₂ (carbon dioxide) | - PH ₃ (phosphorus trihydride) |
| - Mg _{0.50} Al _{0.25} Ti _{0.25} | - XeF ₄ (xenon tetrafluoride) |
| - H ₂ O (water) | - SiO ₂ (quartz) |
| - H ₅ C ₂ OC ₂ H ₅ (diethyl ether) | - Au (gold) |
| - H ₂ CCl ₂ (methylene dichloride) | - C ₃ H ₈ (propane) |
| - NH ₃ (ammonia) | - C ₁₄ H ₁₀ (anthracene) |

Ionic Crystals (including crystals containing polyatomic ions)	Covalently Bonded Compounds				Metallic Crystals
	Covalent Network Crystals	Discrete Covalent Molecules			
		van der Waal (intermolecular force)	dipole inter-action (intermolecular force)	hydrogen bond (intermolecular force)	
(NH ₄) ₂ SO ₄	C _n	SiCl ₄	H ₅ C ₂ OC ₂ H ₅	HCOOH	Mg _{0.50} Al _{0.25} Ti _{0.25}
Li ₃ N	SiO ₂	CO ₂	H ₂ CCl ₂	C ₂ H ₅ OH	Au
NH ₄ NO ₃		PH ₃		H ₂ O	
K ₂ O		XeF ₄		NH ₃	
		C ₃ H ₈			
		C ₁₄ H ₁₀			

3. For each pair of compounds, circle the one with the higher melting and/or boiling point. In the space provided give the rationale for your choice. Including precise reference to the attractive forces that must be overcome to melt or boil each compound as well as any other forces that may be present and why this leads to the choice you have made. Be specific as to whether the forces that must be overcome are intramolecular or intermolecular. Include any additional relevant information that has helped your choice. Use point form.

-
- d) C₅H₁₂ vs C₃H₈
- both compounds are discrete covalent molecules with only intermolecular v.d.w. forces
 - the pentane has more electrons etc. and therefore greater v.d.w. forces
 - greater intermolecular forces, higher m.p. and b.p.

-
- b) SiO₂ vs SiF₄
- SiO₂ is a macromolecule, therefore to melt or boil, intramolecular covalent bonds must be broken to create particles that are small enough to be a liquid or gas
 - SiF₄ is a discrete non-polar covalent molecule, only weak intermolecular v.d.w. forces must be overcome to melt and boil
 - intramolecular covalent much greater than v.d.w. intermolecular, therefore SiO₂ has a much higher m.p. and b.p.

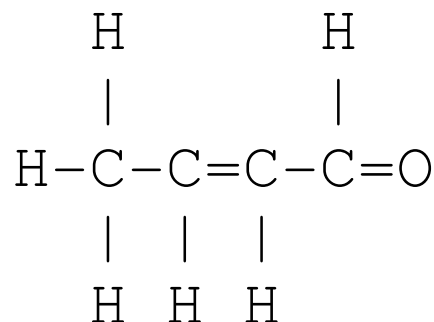
-
- c) H₂CCl₂ vs CF₄
- dichloromethane is a discrete polar covalent molecule (asymmetrical) with dipole intermolecular forces
 - tetrafluoromethane is a discrete non-polar molecule (symmetrical) with v.d.w. intermolecular forces only
 - dipole is a stronger force than v.d.w., therefore the polar molecule has higher m.p. and b.p.
 - note that both molecules have exactly the same number of e⁻ etc and therefore the v.d.w. present in both molecules should be the same, the added dipole is what makes the difference

-
- d) K vs Ca
- Ca → Ca²⁺ + 2e⁻ vs K → K¹⁺ + 1e⁻
 - therefore Ca has a greater ionic charge and a thicker electron soup, hence a stronger metallic bond

4. Match each description with the term it best describes.

h	always present between molecules within liquids or solids composed of discrete covalent molecules	a) ionic bonding
l	most diverse and specific type of bonding, well studied and complex	b) dipole interactions
m	occupies the lattice points in ammonium nitrate (NH_4NO_3)	c) anisotropic
i	property that is used when determining bond type or bond polarization possibilities	d) metallic bonding
j	requires hard charge polarization and lone pair interaction with N, O or F	e) alloy
o	sp , sp^2 , sp^3 are examples of	f) covalent network crystal
n	a solid that has molecules as the lattice points	g) sigma
c	an adjective that describes a physical property that has a directional characteristic	h) van der Waal force
a	creates macromolecules that may be soluble in water	i) electronegativity
k	type of bond that has little effect on shape	j) hydrogen bond
f	non-conductive in any state, insoluble in all solvents	k) pi
e	a solid that can have variable composition, a solid solution	l) covalent bonding
g	forms the core (central bond) of double and triple bonds	m) polyatomic ions
b	present when bond polarizations and geometry make possible regions of partial positive and partial negative charge	n) molecular solid
d	produces strong yet flexible bonds	o) hybridized atomic orbitals

5. For the given structure identify all bonds as either sigma (σ) or pi (π).



6. Describe in detail the structure of graphite and use this information to explain the anisotropic property that is unique to this compound. A diagram may be helpful.

planes of trigonal planar carbon atoms forming sheets of six membered rings, sigma bond framework of six membered rings, pi bonds between alternate carbon atoms (strong "intraplanar" covalent bonds)

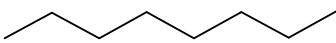
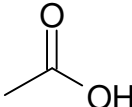
planes are held together by weak "interplanar" v.d.w. forces

conductivity is anisotropic in "good" graphite, pi bonds can flip position (electronic resonance) within the planes of carbon atoms, the double bonds can effectively "walk" across the planes, this allowing for conductivity (delocalized pi electrons), therefore conductivity along the planes

conductivity cannot occur between the planes because the pi bonds cannot flip between planes, non-conductive between planes

see graphite diagrams!

7. Given the following structures and information:

	M.P.	B.P.
	-57 °C	126 °C
	-17 °C	118 °C

a) what class of compounds (ionic, covalent network, discrete covalent molecules, or metallic) do these substance belong to?

discrete covalent

b) what are ALL of the intermolecular forces present in the first compound (octane) in order of decreasing strength

v.d.w.

c) what are ALL of the intermolecular forces present in the second compound (acetic acid) in order of decreasing strength

H-bond → dipole → v.d.w.

d) offer a good explanation as to why the boiling point of octane is higher than acetic acid

the larger size of the octane molecule means that the v.d.w. forces (only intermolecular force present) have become strong enough to raise the boiling point above that of the acetic acid (which has a H-bond → dipole → v.d.w. intermolecular force)

in other words, a strong v.d.w. will beat a hydrogen bond

e) offer a good explanation as to why the trend in melting point is reversed for these two compounds

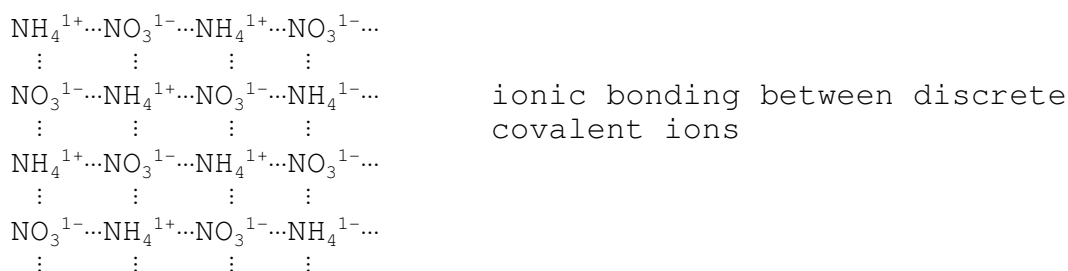
the long snaky octane makes a poor solid (lattice structure is absent or very disorganized), acetic acid is better able to form a lattice, in part with dimers (two molecules doubly hydrogen bonded together), the better lattice makes for stronger forces of attraction in the solid hence a higher m.p.

8. Why is the compound NH_4NO_3 non-conductive in the solid state but conductive in both the liquid state and in aqueous solution? What is special about the classification of this compound given its atomic make-up?

solid state: ions are locked in place with in the crystal lattice (electrons are fixed to ions), no free moving charged particles therefore no conduction

aqueous and liquid state: NH_4^{1+} and NO_3^{1-} ions are free to move and able to provide conduction (nothing to do with free moving electrons)

the classification of this compound is clearly ionic macromolecule, the special part is that this is accomplished without a metallic cation (polyatomic ions instead)



9. For the following solute, solvent pairs indicate if the solute is soluble in the given solvent or not. If soluble, what are the smallest units present - be precise. If not soluble, leave this column blank or write N.A.

SOLUTE	SOLVENT	YES/NO	SMALLEST UNITS OF SOLUTE
KBr	water	yes	K^{1+} and Br^{1-} ions
Au (gold)	Hg (mercury)	yes	Au atoms (Au ions plus a complement of electrons)
$\text{C}_{50}\text{H}_{102}$ (wax)	water	no	
$(\text{NH}_4)_2\text{SO}_4$	water	yes	NH_4^{1+} and SO_4^{2-} ions
$\text{C}_{50}\text{H}_{102}$ (wax)	C_5H_{12} (pentane)	yes	$\text{C}_{50}\text{H}_{102}$ molecules