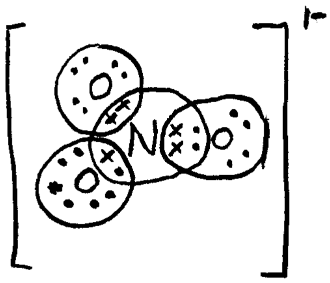
/114 = %

Name:________________

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-}

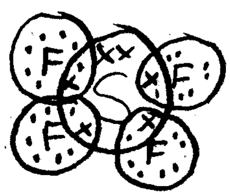


total # of e^- pairs	4
σ bonding pairs	3
lone pairs	0
π bonding pairs	1
base shape	trigonal planar
actual shape	trigonal planar
approx. bond angles	~120°

oxidation state of N $^{5+}$

/8

SF_4

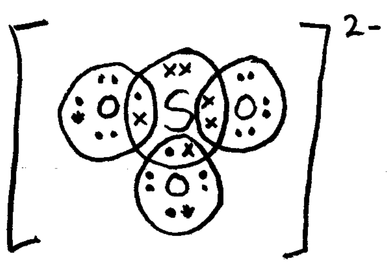


total # of e^- pairs	5
σ bonding pairs	4
lone pairs	1
π bonding pairs	0
base shape	trigonal bipyramidal
actual shape	see - saw
approx. bond angles	120° + 90°

oxidation state of S $^{4+}$

/8

SO_3^{2-}



total # of e^- pairs	4
σ bonding pairs	3
lone pairs	1
π bonding pairs	0
base shape	tetrahedral
actual shape	pyramidal
approx. bond angles	< 109.5°

oxidation state of S $^{4+}$

/9

/25

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

BF_3 (boron trifluoride)

C_3H_7COOH (butanoic acid)

$CH_3CHOHCH_3$ (isopropyl alcohol)

CH_3COCH_3 (acetone - a ketone)

$Cu_{0.85}Zn_{0.10}Sn_{0.05}$ (brass)

$HSiCl_3$ (trichlorosilane)

Na_2CO_3 (sodium carbonate)

SiC (silicon carbide m.p. = 2730 °C)

$SnCl_4$ (tin tetrachloride b.p. = 114 °C)

XeF_4 (zenon tetrafluoride)

$C_{12}H_{25}OH$ (1-dodecanol)

$C_{12}H_{26}$ (dodecane)

C_2H_2 (acetylene)

C_n (diamond)

CO_2 (carbon dioxide)

H_2O (hydrogen oxide)

N_2 (nitrogen gas)

Na_2O (sodium oxide)

SiO_2 (quartz)

W (pure tungsten)

Ionic Crystals (including crystals containing polyatomic ions)	Covalently Bonded Compounds				Metallic Crystals
	Covalent Network Crystals	Discrete Covalent Molecules			
		van der Waal (intermolecular force)	dipole interaction (intermolecular force)	hydrogen bond (intermolecular force)	
Na_2CO_3	SiC	BF_3	CH_3COCH_3	C_3H_7COOH	CuZnSn
Na_2O	C_n	$SnCl_4$	$HSiCl_3$	$CH_3CHOHCH_3$	W
	SiO_2	XeF_4		$C_{12}H_{25}OH$	
		C_2H_2		H_2O	
		$C_{12}H_{26}$			
		← CO_2 →	← CO_2 →		
		N_2			

N_2 (g) does not have an intermolecular

δ^- :O=C=O: δ^- (δ^+ on C) although CO_2 is not a dipole it can have dipole interactions

/20

3. For each pair of compounds, circle the one with the higher melting and/or boiling point. In the space provided give the rational 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.

a) Mg vs (Al)

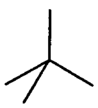
- metallic intramolecular forces only
- $Mg \rightarrow Mg^{2+} + 2e^-$ vs $Al \rightarrow Al^{3+} + 3e^-$
- Al has greater ionic charge and thicker "e^- soup" ∴ higher M.p. + b.p.

/3

b) (SiO_2) vs CO_2

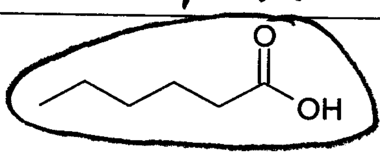
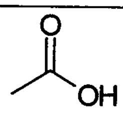
- covalent intramolecular forces with intermolecular dipole (or v.d.w.) for CO_2 only
- SiO_2 is a covalent network solid, CO_2 a discrete covalent molecule
- must break cov. bond in SiO_2 but only dipole intermolecular in CO_2

/3

c)  vs  consider b.p. only

- covalent intramolecular forces, v.d.w. intermolecular forces
- v.d.w. forces equivalent w/ # of e^-
- pentane is a long snaky molecule with better overlap in the liquid state

/3

d)  vs 

- covalent intramolecular forces, H-bond intermolecular forces
- greater underlying v.d.w. forces in the larger acid

/4

/13

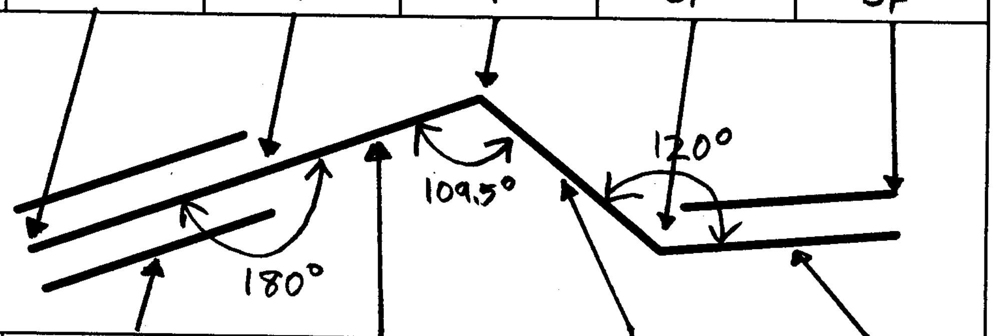
4. Match with the **BEST** possible term:

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

15

5. For the organic structure shown, label the hybridization for each carbon atom (i.e. sp^3, sp^2, sp). Label each bond according to bond type (i.e. σ, π). Add the bond angles that exist within the carbon framework (do not consider any hydrogen atoms). Finally state the shape (i.e. octahedral) that each carbon atom uses for its bonding. Note that in all cases, base electron shape and actual shape are the same, therefore one shape name per atom will do.

Shape	linear	linear	tetrahedral	trigonal planar	trigonal planar
Hybridization	sp	sp	sp^3	sp^2	sp^2



Bond Type	$\sigma + 2\pi$	σ	σ	$\sigma + \pi$

$\sigma + \pi + \pi$

$\sigma + \frac{\pi}{2} + \frac{\pi}{2} + \frac{\pi}{2} + \frac{\pi}{2}$

$\sigma + \frac{\pi}{2} + \frac{\pi}{2}$

/9

6. Why are the planes in graphite flat? Include all specifics about the forces present in the planes. What forces exist between the planes. Why is conductivity observed within a plane, but not between planes? Be precise.

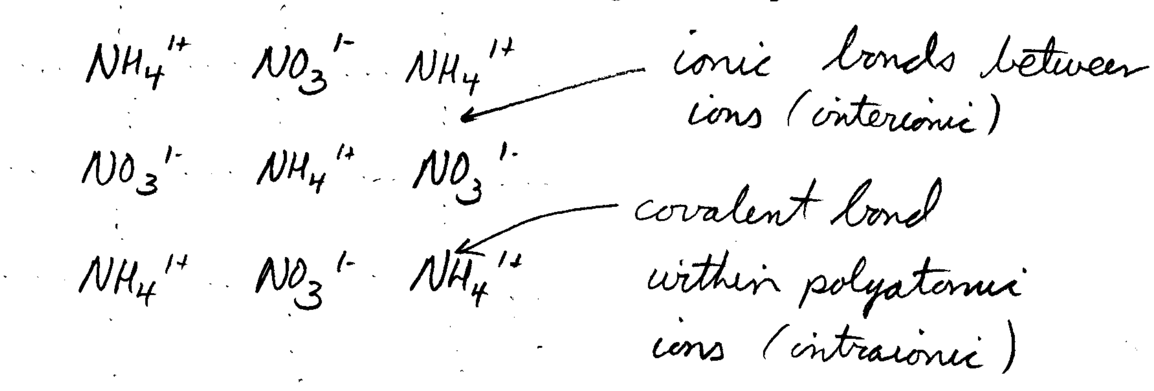
- carbons are sp^2 hybridized trigonal planar in shape
- covalent bonds, σ framework with alternate π bonds (conjugated)
- v.d.w.
- π e^- are delocalized (can flip position)
- π e^- cannot flip between planes (no σ bonds between planes ∴ π cannot exist between planes)

/6

/15

7. For the NH_4NO_3, the solid state is completely non-conductive. However when dissolved in water, the resulting solution becomes conductive.

a) Draw a 2-dimensional diagram that represents the lattice structure for ammonium nitrate in solid form. Label two different forces present in your diagram.



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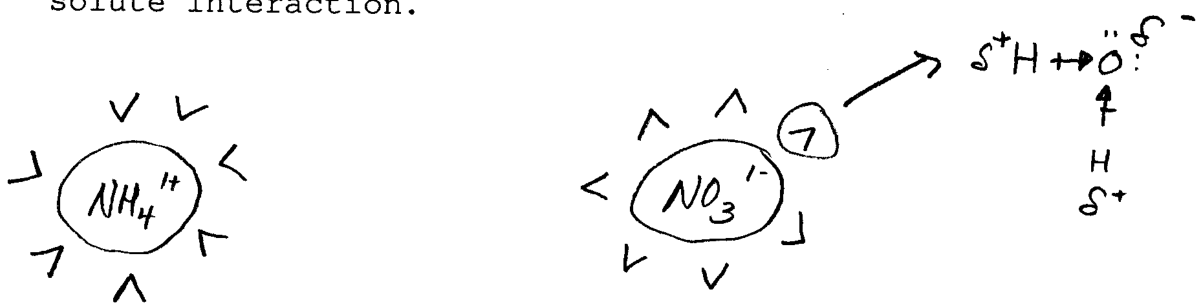
b) For the forces you have named in a), which force must come first? Explain.

covalent bonds are required to create ions which make the ionic bond possible 2

c) What occupies the lattice point in the solid - be precise (you may answer using symbols)

NH_4^{1+} and NO_3^{1-} ions 2

d) Draw a sketch that clearly shows all aspects of the solvent solute interaction.



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e) Why is this solid non-conductive?

ions cannot move 1

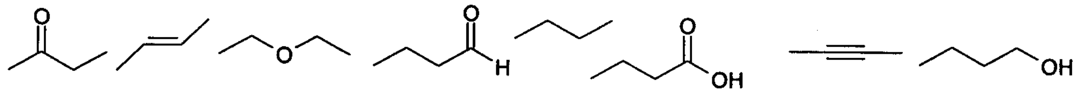
f) Why is the aqueous state conductive? What are the charge carriers?

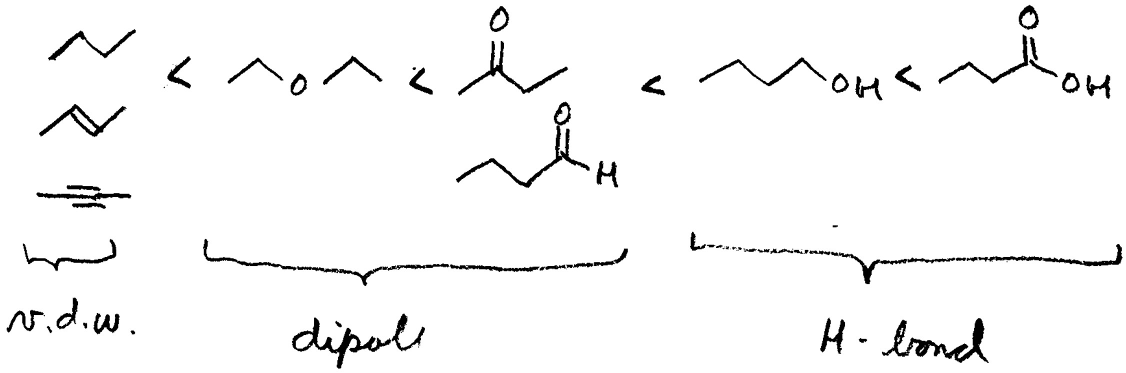
- ions can move 2

- NH_4^{1+} & NO_3^{1-} ions

15

8. For each of the following substances, organize in order of **INCREASING** melting and boiling point (lowest melting point to the left). State the intermolecular forces at play for each substance. It is possible that some of these compounds have roughly the same M.P. and B.P.





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9. Why is lead(II) chloride ($PbCl_2$) slightly soluble in water, while lead(II) nitrate ($Pb(NO_3)_2$) is highly soluble in water? Explain with reference to appropriate terminology.

$PbCl_2$ lattice energy > hydration energy

$Pb(NO_3)_2$ hydration energy > lattice energy

3

NO_3^{1-} hydrates much more effectively than Cl^{1-} (perhaps hard charge vs soft charge, NO_3^{1-} may also H-bond with water)

11