— = 7

Name: _____

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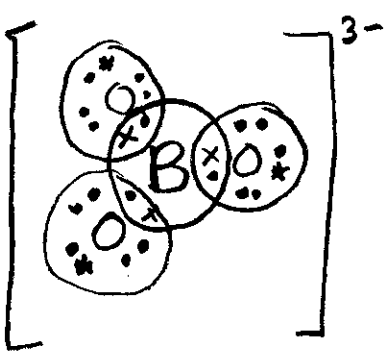
SCH 4U Unit Test
Forces and Molecular Properties

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

BO_3^{3-} 	total # of e^- pairs	3
	σ bonding pairs	3
	lone pairs	0
	π bonding pairs	0
	base shape	trigonal planar
	actual shape	trigonal planar
oxidation state of B +3	approx. bond angles	120°

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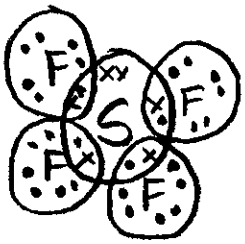
SF_4 	total # of e^- pairs	5
	σ bonding pairs	4
	lone pairs	1
	π bonding pairs	0
	base shape	trigonal bipyramidal
	actual shape	see-saw
oxidation state of S +4	approx. bond angles	90°, 120°

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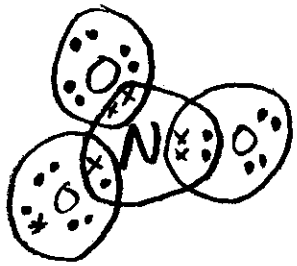
NO_3^{1-} 	total # of e^- pairs	4
	σ bonding pairs	3
	lone pairs	0
	π bonding pairs	1
	base shape	trigonal planar
	actual shape	trigonal planar
oxidation state of N +5	approx. bond angles	~120°

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

- H_2O (water)
- SF_6 (sulphur(VI) fluroide)
- Ag (silver)
- CH_3COOH (acetic acid)
- KI (potassium iodide)
- C_4H_{10} (butane)
- $HCCl_3$ (chloroform)
- C_n (diamond)
- CH_3OH (methyl alcohol)
- Li_2O (lithium oxide)
- $C_6H_5CH_3$ (toluene)
- CO_2 (carbon dioxide)
- SiO_2 (quartz)
- NH_4NO_3 (ammonium nitrate)
- HF (hydrogen fluoride)
- $Cu_{0.85}Zn_{0.10}Sn_{0.05}$ (brass)
- KNO_3 (potassium nitrate)
- PCl_3 (phosphorus trichloride)
- CF_4 (carbon tetrafluoride)
- $H_5C_2OC_2H_5$ (diethyl ether)

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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)	
KI Li_2O NH_4NO_3 KNO_3	Cn SiO_2	SF_6 C_4H_{10} $C_6H_5CH_3$ CO_2 CF_4	$HCCl_3$ $H_5C_2OC_2H_5$ CO_2^* PCl_3	H_2O CH_3COOH CH_3OH HF	Ag CuZnSn

* $S^- :\ddot{O}=\overset{S^+}{C}=\ddot{O}: S^-$

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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) (NH_3) vs CH_4 - both are dis. cov. molecules ∴ compare intermolecular forces
- NH_3 intermolecular H-bond (intramolecular cov. unaffected)
- CH_4 intermolecular v.d.W. (intramolecular cov. unaffected)
- H-bonds are stronger and harder to overcome than v.d.W. ∴ NH_3 has higher M.P. + B.P.

/4

b) (Sc) vs K
- both are metallic (∴ v.d.W. are not involved)
- $Sc \rightarrow Sc^{3+} + 3e^-$ vs $K \rightarrow K^{1+} + 1e^-$
- Sc has greater ionic charge and stronger e- soup ∴ harder to melt or boil

/4

c) CO_2 vs (SiO_2)
- CO_2 dis. cov. molecule, must overcome v.d.W. intermolecular force
- SiO_2 cov. net. solid, must overcome cov. bond
- cov. bond >>> intermolecular v.d.W ∴ harder to melt or boil SiO_2

/4

d) ($H_5C_2OC_2H_5$) vs C_5H_{12} - both dis. cov. molecules ∴ compare inter. forces
- ^o^ intermolecular dipole
- ^^ intermolecular v.d.W.
- dipole > v.d.W. ∴ harder to melt ^o^

/4

Note - underlying v.d.W. is equal

^o^ → 42e⁻ ^^ → 42e⁻

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4. Match each definition with the word it best describs:

13	electrons that do not affect the shape of a molecule	1.	anisotropic
11	an intramolecular force that is influenced by the number of electrons available in the valence shell	2.	coordinate covalent bond
3	a term used to describe the ability of double bond electrons in graphite planes to flip location	3.	delocalized
6	necessary for hydrogen bonding to occur	4.	discrete covalent molecule
2	uneven electron pair sharing	5.	electronegativity
8	type of energy associated with the strength of a solid ionic crystal	6.	exposed proton
16	an intermolecular force that is influenced by the total number of electrons found in a discrete covalent molecule	7.	hydration
1	describes a feature of conductivity that is unique to graphite	8.	lattice
7	type of energy associated with the interaction between water molecules and dissolved ions	9.	lone pair
5	a property used to determine the degree of polarization within a single covalent bond	10.	macromolecule
10	unspecified and large number of atoms or ions bonded together by an intramolecular force	11.	metallic
9	produces difference between actual shape and base electron shape		
14	type of covalent bond that is used by halogens and halogen like oxygens	13.	pi
4	must be present before intermolecular forces can be considered	14.	sigma
15	most common place base shape	15.	tetrahedral
		16.	van der Waals

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5. Organize the following list in order of decreasing solubility in water. Give some clear reasoning behind your choice using the appropriate vocabulary from this unit.

alcohol, aldehyde, alkane, carboxylic acid, alkyne, ether, ketone, alkene

carboxylic acid > alcohol > ketone aldehyde > ether > alkane alkene alkyne

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decreasing polarity

replacement force	2-way H-bond	2-way H-bond	1 way H-bond	dipole interact	v.d.w. only
		soluble		insoluble	

- water molecules are strongly attracted to each other, must replace the 2-way H-bond between water molecules

6. Explain the reason for the observed conductivity or lack there of in the following substance (note the states):

iron (s)	good - free moving e^- in the e^- soup of the metallic bond
NaCl (aq)	good - free moving Na^{1+} and Cl^{1-} ions in solution
graphite (s)	- good in planes due to pi bond slippage - nil from plane to plane (pi bonds cannot slip in this way
NaCl (s)	- nil - no free moving charged particles
SiO_2 (s)	- nil - no free moving charged particles
$C_{25}H_{52}$ (l)	- nil - no free moving charged particles

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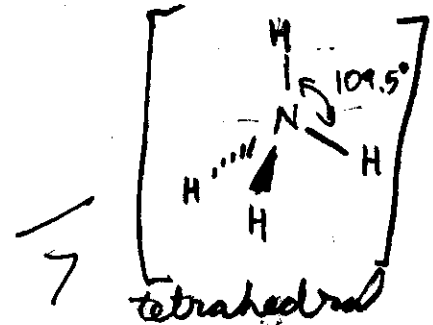
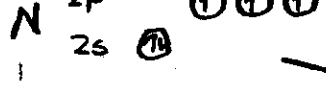
7. Provide any and all information that you possibly can about the substance ammonium nitrate (NH_4NO_3). This is an open ended question. Here are some ideas, but feel free to add more! What force, or forces are present in the solid state? What type of compound is this? What are the individual units within the solid lattice structure? What are the shape details of these units? What is the solubility of the this substance in water or in non-polar substances such as hexane. Use point form and diagrams. Some marks are for presentation.



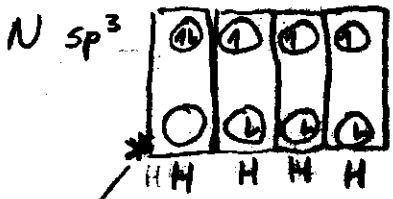
AO for N



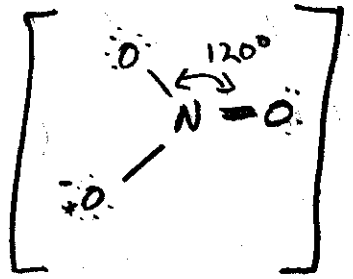
MO for N with overlap to H's

N is an sp^3 hybrid

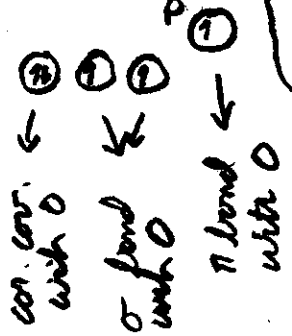
$s + p + p + p \Rightarrow 4 \times sp^3$



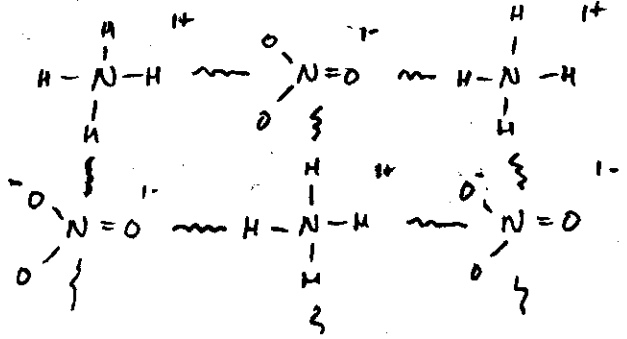
coordinate covalent bond



N sp^2



ionic lattice structure



lattice structure

— = covalent bond within ions

~~~ = ionic bond between ions NH_4^{1+} and NO_3^{1-} at lattice points

- excellent solubility in water (both NH_4^{1+} & NO_3^{1-} hydrate well)
- poor solubility in hexane (unlike)
- conductivity (s) → nil
  (aq) → good
  (l) → good

- used to make ANFO (ammonium nitrate/fuel oil)
- VERY EXPLOSIVE
- endothermic heat of solution
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