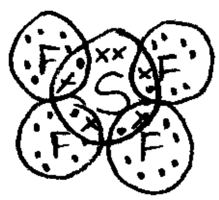
/125 = %

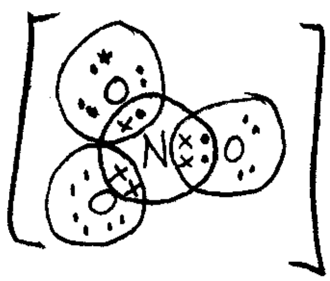
Name:________________

SCH 4U Unit Test
Forces and Molecular Properties

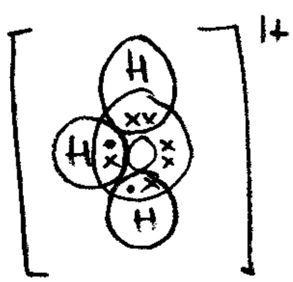
1. Fill in each table as done on the assignment. Including the oxidation state of the central atom:

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	<120°, <90°

/8

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°

/8

H_3O^{1+} 	total # of e^- pairs	4
	σ bonding pairs	3
	lone pairs	1
	π bonding pairs	0
	base shape	tetrahedral
	actual shape	pyramidal
oxidation state of O 2-	approx. bond angles	<109.5°

/9

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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:

- C_n (diamond)
- Fe (iron)
- LiF (lithium fluoride)
- K_2SO_4 (potassiu sulphate)
- CO_2 (carbon dioxide)
- C_3H_8 (propane)
- CH_3COCH_3 (acetone)
- H_2O (water)
- $Fe_{0.95}Ni_{0.05}$
- Br_2
- $C_2H_5OC_2H_5$ (ether)
- C_3H_7OH (isopropyl alcohol)
- NH_3 (ammonia)
- NH_4NO_3 (ammonium nitrate)
- CH_3COOH (acetic acid)
- Si (silicon) (b.p. = 3538 K)
- PH_3 (phosphorus trihydride)
- SiO_2 (quartz)
- C_6H_6 (benzene)
- O_2 (oxygen)

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)	
LiF	C_n	CO_2 ↔		H_2O	Fe
K_2SO_4	Si	C_3H_8	CH_3COCH_3	C_3H_7OH	$Fe_{0.95}Ni_{0.05}$
NH_4NO_3	SiO_2	Br_2	$C_2H_5OC_2H_5$	NH_3	
		PH_3		CH_3COOH	
		C_6H_6			
		O_2			

20/20

20/20

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) (NH_3) vs CH_4 - both discrete covalent molecules (intra cov. bond)

- NH_3 has H-bond intermolecular
- CH_3 has v.d.w. only
- H-bond > v.d.w therefore more energy required to melt NH_3

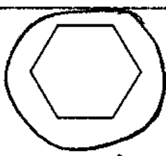
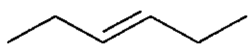
/4

b) (Al) vs Mg - both metallic intramolecular bonds (macro)

$Al \rightarrow Al^{3+} + 3e^-$
$Mg \rightarrow Mg^{2+} + 2e^-$ } ∴ Al has greater ionic charge and greater

∴ stronger metallic bond in Al ∴ higher M.P.

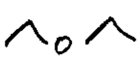
/4

c)  vs  (melting point only) - both discrete covalent molecules

- both non-polar ∴ only v.d.w. intermolecular forces (also same size ∴ same v.d.w. strength)
- cyclohexane will pack into solid form with better crystal structure ∴ better v.d.w. in solid state

/4

d) ($H_5C_2OC_2H_5$) vs C_5H_{10} - both discrete covalent molecules

 is dipole - dipole intermolecular force

 is v.d.w. only

dipole > v.d.w. ∴ high M.P. for 

/4

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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 (cental 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

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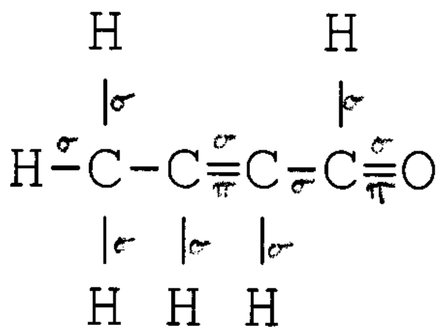
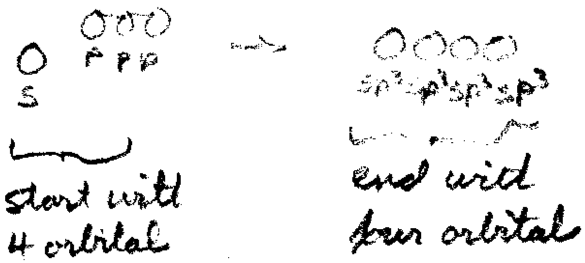
5. For the given structure identify all bonds as either sigma (σ) or pi (π).



/2

6. Why does the sp^3 hybridization process always produce four sp^3 hybrid orbitals. What base (or actual) shape is made possible by sp^3 hybridization?

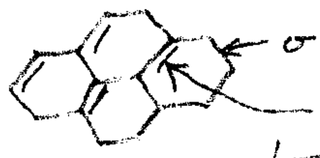


tetrahedral configuration

/2

7. Describe in detail the structure of graphite (all forces and perhaps diagrams). Include information about the special type of conductivity observed in graphite. What key words can be used to help explain the conductivity in graphite.

top view

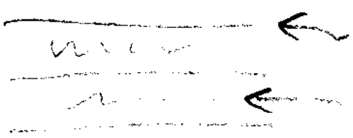


σ bond framework
delocalized π bond } plane structure

all forces are intraplanar covalent bonds

/5

side view

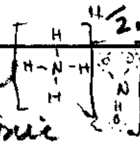


← plain
← v.d.w. interplanar force

- π bonds can flip position within planes allow conductivity through planes (delocalized π electrons)
- conductivity cannot occur between plains
∴ anisotropic conductivity

/9

8. Fill in the following table to show all attractive force present in the given state as well as the classification of the force (i.e intramolecular - covalent, intermolecular - v.d.w.). If the force does not classify as intra or intermolecular, describe sufficiently. Please note that the forces involved may change with state!!

	solid	liquid	gas
diamond (C_n)	covalent intramolecular /2	This fill which looks remarkably like a plane in graphite as seen from above means that you should not put any information in this area!	no forces /1
NH_4NO_3	covalent  intraionic ionic (between NH_4^+ + NO_3^-) interionic /2		
quartz ($(SiO_2)_n$)	covalent intramolecular /2		
carbon dioxide (CO_2)	covalent intramolecular v.d.w intermolecular /2		covalent intramolecular /1
water (H_2O)	covalent intramolecular H-bond intermolecular /2	covalent intramolecular H-bond intermolecular /2	covalent intramolecular /1
methane (CH_4)	covalent intramolecular v.d.w. intermolecular /2	covalent intramolecular v.d.w. intermolecular	covalent intramolecular /1
iron (Fe)	metallic intramolecular /1	metallic attraction /1	no forces /1

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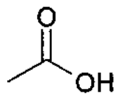
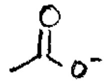
9. What are the charge carriers in each of the following conductive substances. Be precise! Write N.A. if conductivity would be absent.

any metal in solid state	free e-
solution of sodium chloride (NaCl)	Na^{1+} and Cl^{1-} ions
solution of ammonium nitrate (NH_4NO_3)	NH_4^{1+} and NO_3^{1-} ions
solution of acetic acid 	 and H^{1+} ions
quartz	N.A.

8

10. What are the smallest units of solute in each of the following solutions? Be precise! If the given combination will not form a solution, write N.A.

wax ($C_{50}H_{102}$) dissolved in hexane (C_6H_{14})	individual C_5H_{102} molecules
wax ($C_{50}H_{102}$) dissolved in water (H_2O)	N.A.
NaCl dissolved in hexane (C_6H_{14})	N.A.
NaCl dissolved in water (H_2O)	Na^{1+} and Cl^{1-} hydrated ions
$(NH_4)_2CO_3$ dissolved in water (H_2O)	NH_4^{1+} and CO_3^{2-} hydrated ions
Au dissolved in mercury (Hg)	Au atoms ($Au \rightarrow Au^{3+} + 3e^-$)
P(s) dissolved in carbon disulphide (CS_2)	P_4 units in non-polar CS_2

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