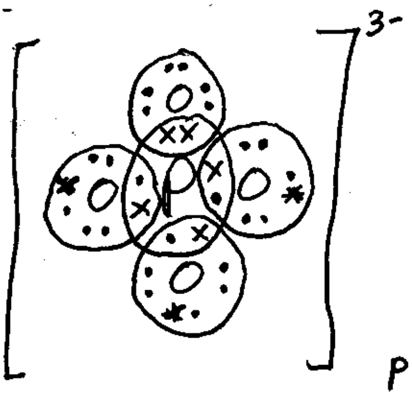
$\frac{\quad}{100}$ =

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:

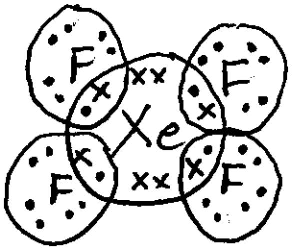
PO_4^{3-}



P^{5+}

total # of e⁻ pairs	4
σ bonding pairs	4
lone pairs	0
π bonding pairs	0
base shape	tetrahedral
autual shape	tetrahedral
approx. bond angles	109.5°

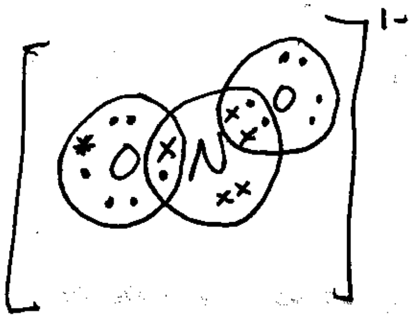
XeF_4



Xe^{4+}

total # of e⁻ pairs	6
σ bonding pairs	4
lone pairs	2
π bonding pairs	0
base shape	octahedral
autual shape	square planar
approx. bond angles	90°

NO_2^{1-}



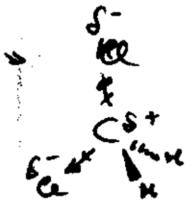
N^{3+}

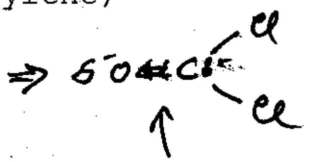
total # of e⁻ pairs	4
σ bonding pairs	2
lone pairs	1
π bonding pairs	1
base shape	Trigonal planar
autual shape	angular
approx. bond angles	< 120°

$\frac{\quad}{25}$

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

- NH_3 (ammonia)
- $AsCl_5$ (arsenic(V) chloride)
- BaF_2 (barium fluoride)
- CuSn (bronze)
- C_3H_7COOH (butanoic acid)
- 24Cr (chromium)
- $C_{10}H_{22}$ (decane)
- C_n (diamond)
- H_2CCl_2 (dichloromethane)
- C_2H_5OH (ethyl alcohol)
- LiF (lithium fluoride)
- $C_6H_4(CH_3)_2$ (para-xylene)
- $COCl_2$ (phosgene)
- SiO_2 (quartz)
- Na_2SO_4 (sodium sulphate)
- H_2O (water)





stronger polarization than C-Cl bond

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)	
BaF_2 LiF Na_2SO_4	C_n SiO_2	$asCl_5$ $C_{10}H_{22}$ $C_6H_4(CH_3)_2$	H_2CCl_2 $COCl_2$	NH_3 C_3H_7COOH C_2H_5OH H_2O	CuSn Cr

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3. How is it possible to have an ionic solid (high M.P and B.P. dissolves in water, crystal structure) that is composed entirely of non-metal atoms. An example would help.

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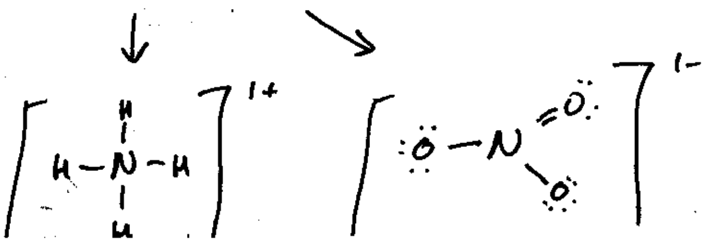
NH_4NO_3 – uses polyatomic ions composed of non-metals



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4. Fill in the blanks! Be sure to use the word that best suits the particular situation. This may include N.A.

a) The intermolecular forces between gas molecules is

N.A.

b) The intermolecular force within a diamond lattice is

N.A.

c) In ammonium nitrate (NH_4NO_3), what occupies the lattice points polyatomic ions

d) A type of force that is present between molecules in <u>any</u> molecular solid or molecular liquid van der Waals

e) A type of force that requires strong molecular polarization and lone pair interaction hydrogen bond

f) A type of force that is required before van der Waals, dipole interactions or hydrogen bonding are possible

covalent bonding

g) A particular type of covalent bonding that makes possible the anisotropic (means different in different directions) conductivity observed in a 2-dimensional network solids such as graphite π bonding (double bond)

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h) A type of bond that does not alter the number of valence electrons around the central atom in a discrete covalent molecule or polyatomic ion coordinate covalent bond

i) Is based on electronegativity and tells you how many electrons a atom can lay claim to. oxidation state

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5. 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 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) [✓ H_2O] vs H_2S

- H_2O molecules attracted to each other by H-bond ← both intermolec ↓
- H_2S molecules attracted to each other by v.d.w. (or dipol
- since H-bonds are stronger than v.d.w. ∴ H_2O has a higher M.P. + B.P. (only intermolecular need be overcome)

b) CO_2 vs [✓ SiO_2]

- CO_2 molecules are discrete covalent molecules with ~~an~~ a v.d.w (or dipole) intermolecular force
- SiO_2 is a covalent network solid with intramolecular forces only
- intermolecular v.d.w in CO_2 much easier to overcome than intramolecular covalent in SiO_2 ∴ SiO_2 has high M.P. + B.P.

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c) Na vs [✓ Al]

- both are metallic macromolecules (intramolecular forces only)
- $Na \rightarrow Na^{1+} + 1e^-$, $Al \rightarrow Al^{3+} + 3e^-$
- since Al has greater ionic charge and more e⁻ in the soup, ∴ Al has the greater M.P. + B.P.

d) C_4H_{10} vs [✓ C_6H_{14}]

- both are discrete covalent molecules attracted to adjacent molecules by v.d.w. forces (intermolecular)
- the large C_6H_{14} will have greater v.d.w. because it has more e⁻ etc.
- ∴ C_6H_{14} has the higher M.P. + B.P.

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6. For each of the following substances, state if it dissolves in water or not. If it does dissolve in water, what is the smallest unit or units that will be present in water. If it does not dissolve in water, why not.

Substance	Dissolves in Water (Yes or No)	Smallest Units When Dissolved or Why Not Soluble in Water
Ethyl Alcohol (C_2H_5OH)	yes	individual C_2H_5OH molecules
Octane (C_8H_{18})	no	non-polar octane vs polar water
Gold (Au)	no	metals do not dissolve in water because e⁻ cannot be hydrated
Ammonium Chloride (NH_4Cl)	yes	NH_4^{1+} + Cl^{1-} ions

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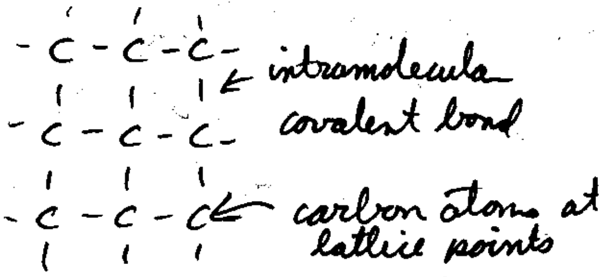
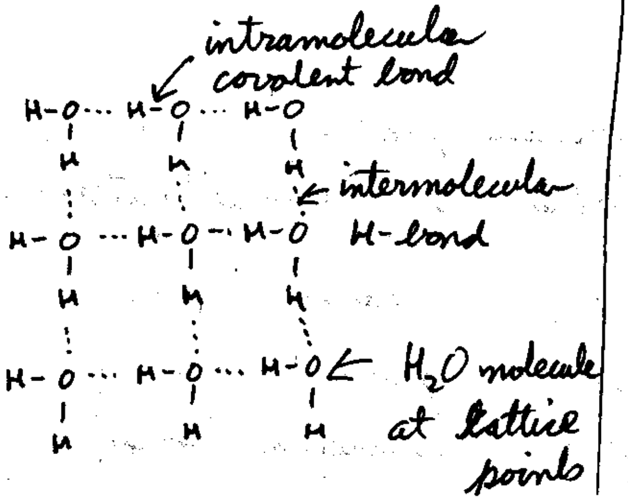
7. Both diamond and ice can form clear solids. The covalent bonds present in ice are 1.33 times stronger than the covalent bonds present in diamond. How then is it possible that ice has a much lower melting point (100 °C) than diamond (approx 4000 °C). Make precise reference to the units present at the lattice points in both crystals and all forces involves in both solids. Diagrams may help.





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To melt or boil water only the intermolecular H-bond must be overcome, leaving the covalent bond between H and O intact.

To melt diamond the intramolecular covalent bond between C atoms must be overcome

It is much larger to break cov. bonds than intermolecular H-bonds ∴ diamond has higher M.P. + B.P.

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8. State the conductivity observed for each of the following substances. Very briefly explain the observed conductivity.

Au(s)	very conductive : free moving electrons can move freely throught empty valence shells in the metal, ∴ conductive
$C_{diamond}$(s)	non - conductive : no free moving charged particles ; e- locked in cov. bonds.
$C_{graphite}$(s)	conductive in planes : π e- are able to flip positions allowing for delocalized electrons to carry the charge non - conductive between planes - electrons cannot ~~p~~ jump from one plane to the next

anisotropic conductivity →

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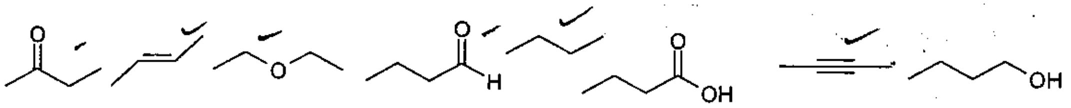
9. For each of the following substances, organize in order of increasing melting and boiling point (lowest melting point to the left). State the intermolecular forces at play for each substance. It is possible that some of these compounds have roughly the same M.P. and B.P.



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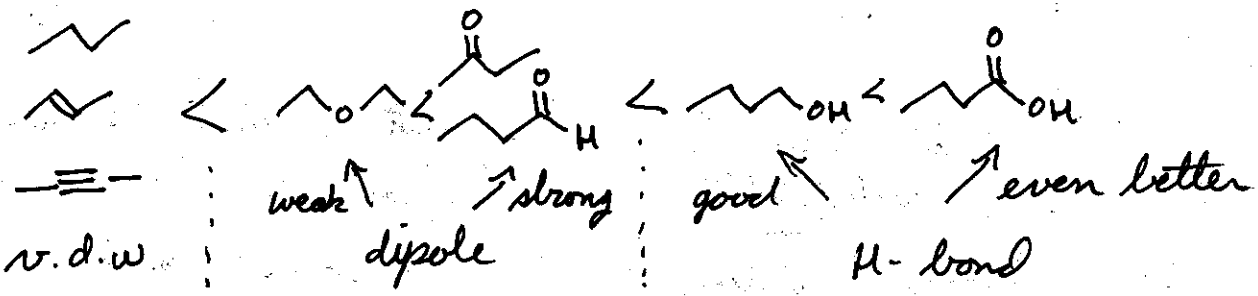

10. Many solid compounds exhibit the property of cleavage. What is this property and how does it work? What are two examples of substances that exhibit cleavage that do not share the same type of bonding

- ability to fracture to produce flat surfaces
- fractures along planes within the crystal lattice structure
- examples 1. C_n or SiO_2 (covalent network)

2. NaCl, NH_4Cl etc (ionic solid)

3. H_2O, $C_6H_{12}O_6$ (molecular solid)

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