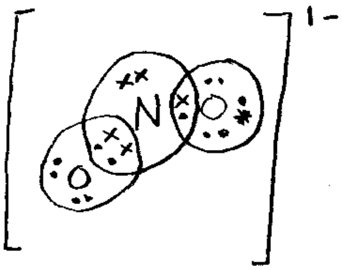
$\overline{96}$ = 8

Name:________________

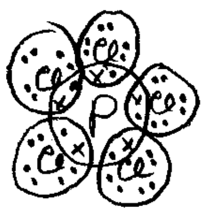
SCH 4U Unit Test

Forces and Molecular Properties

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

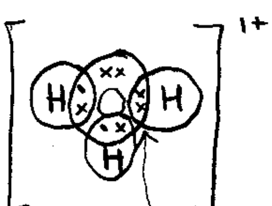
NO_2^{1-} 	total # of e^- pairs	4
	σ bonding pairs	2
	lone pairs	1
	π bonding pairs	1
	base shape	trigonal planar
	actual shape	angular
oxidation state of N $^{3+}$	approx. bond angles	< 120°

/9

PCl_5 	total # of e^- pairs	5
	σ bonding pairs	5
	lone pairs	0
	π bonding pairs	0
	base shape	trig. bipyramidal
	actual shape	trig bipyramidal
oxidation state of P $^{5+}$	approx. bond angles	90° + 120° ← in plane

above and below plane

/7

H_3O^{1+}  coordinate covalent bond!	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

/25

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

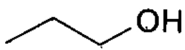
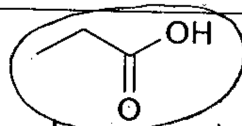
- H_2O (water)
- SF_6 (sulphur(IV) fluroide)
- Fe (~~silver~~) iron
- CH_3COOH (acetic acid)
- LiCl (~~potassium iodide~~) (lithium chloride)
- C_5H_{10} (1-pentene)
- H_2CCl_2 (dichloromethane)
- C_n (diamond)
- C_3H_7OH (isopropyl alcohol)
- Cs_2S (cesium sulphide)
- $C_6H_3(CH_3)_3$ (mesitylene)
- CO_2 (carbon dioxide)
- SiO_2 (quartz)
- NH_4Cl (ammonium chloride)
- HCl (hydrogen chloride)
- $Cu_{0.85}Zn_{0.10}Sn_{0.05}$ (brass)
- $Al(NO_3)_3$ (aluminum nitrate)
- PCl_3 (phosphorus trichloride)
- CF_4 (carbon tetrafluoride)
- C_4H_8O (THF, an ether)

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)	
LiCl	C_n	SF_6	H_2CCl_2	H_2O	Fe
Cs_2S	SiO_2	C_5H_{10}	HCl	CH_3COOH	CuZnSn
NH_4Cl		$C_6H_3(CH_3)_3$	PCl_3	C_3H_7OH	
$Al(NO_3)_3$		CO_2 ⟷	⟷ (CO_2)		
		CF_4	C_4H_8O		

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)  vs 

- both are discrete covalent molecules with H-bond intermolecular forces that need to be overcome to melt or boil
- carboxylic acid has a better H-bond (also a larger molecule ∴ greater underlying v.d.w.) / both lead to stronger forces

4

b) Ca vs K

$Ca \rightarrow Ca^{2+} + 2e^-$ $K \rightarrow K^{1+} + e^-$

- both metallic macromolecules (must overcome metallic bond)
- Ca has larger ionic charges and thicker "e^- soup", ∴ stronger forces

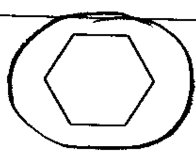
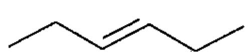
4

c) H_2O vs H_2Se

- H_2O - intermolecular H-bond must be overcome
- H_2Se - intermolecular v.d.w. must be overcome

Since H-bond > v.d.w, stronger intermolecular forces in water

4

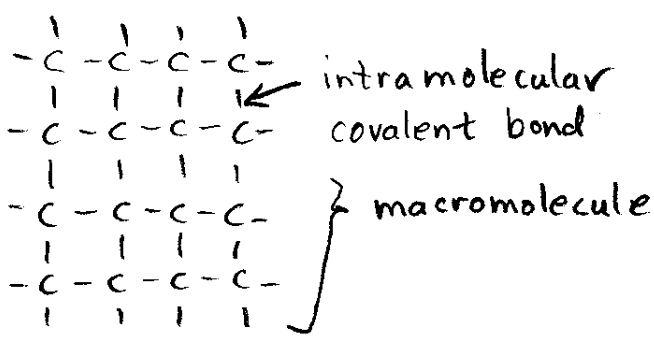
d)  vs  (melting point only)

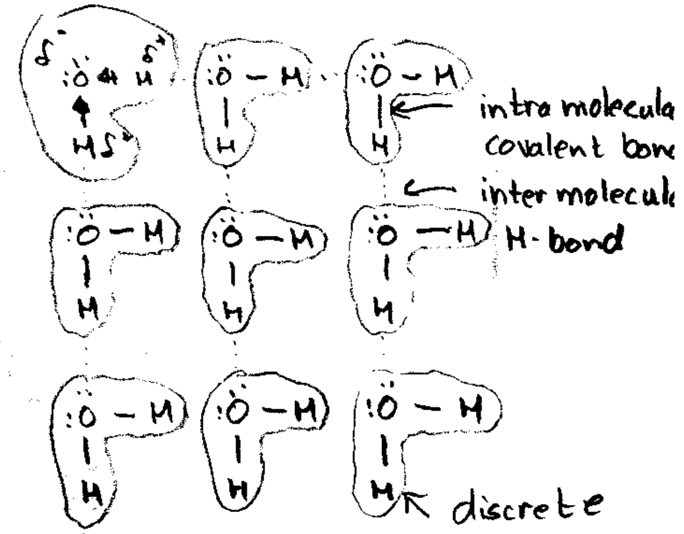
4

- both are discrete covalent molecules with intermolecular v.d.w. forces that must be overcome
- cyclohexane make a better more organized solid crystal structure, ~~therefore~~ harder to melt, ∴ higher M.P.

16

4. Both water and diamond contain covalent bonds. The covalent bond in water has an approximate bond strength of 464 kJ/mol while the single carbon carbon bonds in diamond are approximately 347 kJ/mol. Does this mean that diamond will have a lower melting point in comparison to water. Explain FULLY with reference to attractive forces, diagrams etc. By the way, this is an open ended question. ⇐ NO!





This question is a comparison of macromolecules vs discrete covalent molecules (covalent network solids vs molecular solids) In the later (H_2O) only H-bonds need be broken to melt. In diamond melting cannot occur unless covalent bonds are broken. Since covalent bonds are 10x stronger than H-bonds, diamond must have a much higher melting point The greater strength of the H-O bond does not matter since it is not affected

10

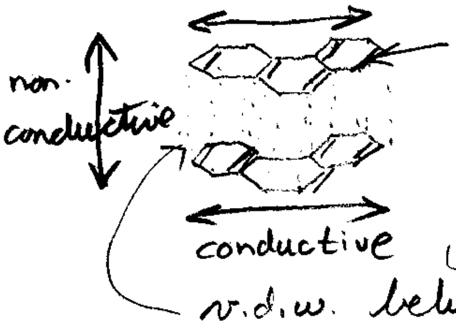
5. Fill in the following table to show all attractive force present in the given state as well as the classification of the force (i.e intramolecular - covalent, intermolecular - v.d.w.). If the force does not classify as intra or intermolecular, describe sufficiently. Please note that the forces involved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

	solid	liquid	gas
diamond (C_n)	covalent intramolecular	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!	N.A.
graphite (C_n)	covalent intraplanar v.d.w. interplanar		N.A.
quartz ($(SiO_2)_n$)	covalent intramolecula		N. A.
carbon dioxide (CO_2)	covalent intramolecular v.d.w. (dipol) intermolecular		covalent intramolecular
water (H_2O)	covalent intramolecula H-bond intermolecula	covalent intramolecular H-bond intermolecular	covalent intramolecula
methane (CH_4)	covalent intramolecular v.d.w. intermolecular	covalent intramolecula v.d.w intermolecula	covalent intramolecula
iron (Fe)	metallic intramolecula	"metallic" forces within the liquid	N.A.

/10 /4 /2

/8

6. Describe anisotropic conductivity. Give and example that you can support with diagrams.

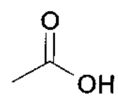
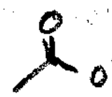


alternate double bonds that can carry e- through electronic resonance with the plane allows for delocalized electrons within a plane - hence conductivity in the plane direction

v.d.w. between planes - conductivity cannot occur between planes (no - conductive between planes)

5

7. What are the charge carriers in each of the following conductive substances. Be precise!

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

5

8. What are the smallest units of solute in each of the following solutions:

wax ($C_{50}H_{102}$) dissolved in hexane (C_6H_{14})	$C_{50}H_{102}$ molecules
wax ($C_{50}H_{102}$) dissolved in water (H_2O)	N.A. doesn't dissolve
NaCl dissolved in hexane (C_6H_{14})	N.A. doesn't dissolve
NaCl dissolved in water (H_2O)	$Na^{1+}(aq)$ + $Cl^{1-}(aq)$
$(NH_4)_2CO_3$ dissolved in water (H_2O)	$NH_4^{1+}(aq)$ + $CO_3^{2-}(aq)$
Au dissolved in mercury (Hg)	Au atoms (Au^{3+} ions)
P(s) dissolved in carbon disulphide (CS_2)	P_4 units in non-polar CS_2

7

17