Name: _____

GENERAL CHEMISTRY
CHEM.111. SEC. 003
EXAM I

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Spring, 2004

Answer all the questions. DO NOT write on this examination paper; use the blank sheets at the end of the exam for your answers. Credit will not be given for numerical questions unless all relevant calculations are shown. Please give answers to numerical questions to 3 significant figures.

1. Explain the origin of the following:

   i) London Dispersion Forces

   ii) Dipole – Dipole Forces

   iii) Hydrogen Bonding

15 points

2. a) In the following compounds indicate the type of bonds either covalent non-polar, covalent polar, ionic, or a mixture of two or more types that are present.

   i) CH_4

   ii) NaCl

   iii) H_2O

   iv) CH_3CH_2OH

   v) CCl_4

10 points

b) For the following compounds indicate which have a permanent dipole.

   i) $C_2 H_6$

   ii) CBr_4

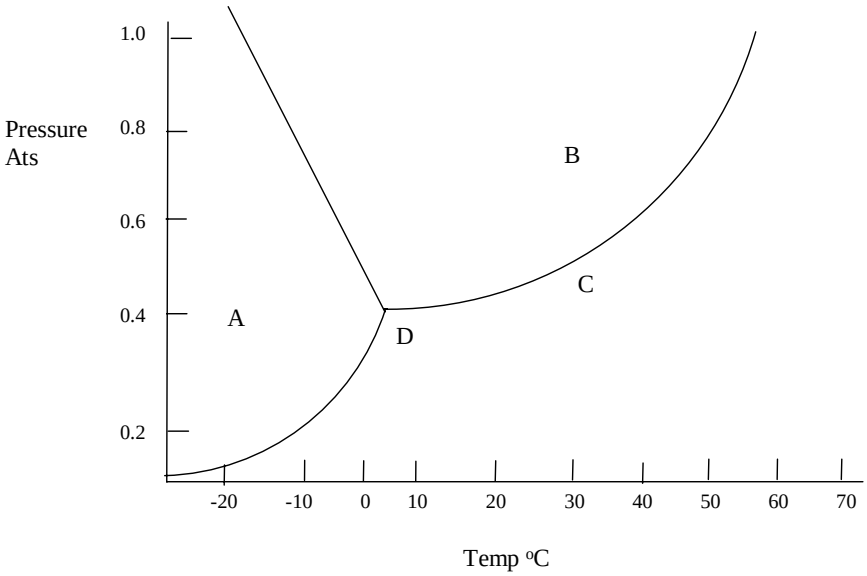
   iii) CH_3Cl

   iv) $CH_3CH_2NH_2$

   v) HCl

10 points

3.



For the phase diagram shown above for a compound P.

i) What phases are present in areas A, B & C?

ii) What phases are present at the boundary A & B, B&C and A&C?

iii) What phases are present at point D?

iv) At 1.0 atmosphere pressure at what temperature will P boil?

v) At 20^{o}C is it possible for P ever to exist as a solid? Explain your answer to get credit.

20 points

4. a) 200g of ethanol (C_2H_5OH) are heated from 10^{o}C to 78^{o}C at which temperature it boils. Calculate how much heat energy will be needed to do the conversion of ethanol from a liquid at 10^{o}C to a gas of 78^{o}C. Given the heat capacity of ethanol is 2.46J.g^{-1}.^{o}C^{-1}and its heat of vaporization in 39.3kJ.mole^{-1}.

10 points

b) The average kinetic energy of a gas, liquid or solid is a measure of what?

2 points

c) Explain or define the following:

i) Unit Cell

ii) Lattice Site

iii) Allotrope

iv) Molecular Solid

8 points

5. a)

Compound	**Dipole Moment (D)**
HF	1.92
H_2O	1.87
NH_3	1.46

i) In the three compounds above what are the forces of interaction?

3 points

ii) Arrange the compounds in order of increasing boiling point based solely on the dipole moment.

3 points

iii) The actual order of increasing boiling point in $NH_3 < HF < H_2O$. Explain this order.

3 points

b)

Compound
C_3H_8
CH_4
C_4H_{10}
C_2H_6

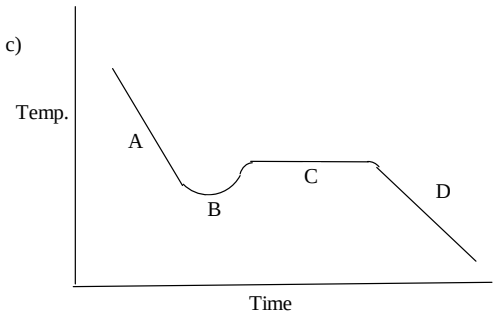
i) Arrange the compounds in order of increasing boiling point.

4 points

ii) Explain your order in (i) above.

4 points

c)



The above is a cooling curve for a compound going from a liquid → solid. Explain what is happening at:

i) A
ii) B
iii) C
iv) D

8 points

ANSWERS

1. i) London dispersion forces arise from the fact that when two or more atoms or molecules approach each other and their respective electron clouds become distorted because of electrostatic repulsion effects. This causes the atom or molecule to become slightly polarized and here there is a slight attraction between the atoms or molecules.

   ii) Dipole – Dipole forces arise in polar molecules that have a permanent dipole. The 'positive end' of one molecule attracts the 'negative end' of another molecule.

   iii) Hydrogen bonding arises when a small very electronegative atom is bonded to hydrogen in a molecule. There is then a very strong attraction between the hydrogen atom on one molecule and the small very electronegative atom (N, O, F) on the other molecule.

2. a) i) CH_4 – covalent – non polar
   ii) NaCl – ionic
   iii) H_2O – covalent polar
   iv) CH_3 CH_3 OH – covalent – non polar and covalent – polar
   v) C Cl_4 – covalent polar

   b) i) C_2H_6 – no dipole
   ii) C Br_4 – no dipole
   iii) CH_3Cl – dipole
   iv) $CH_3CH_2NH_2$ – dipole
   v) HCl – dipole

3. i) A – solid, B – liquid, C – gas
   ii) A/B – solid/liquid, B/C – liquid/gas, A/C – solid/gas
   iii) gas – liquid – solid
   iv) ~ 54°C
   v) No – as the pressure increases in this region of the phase diagram, there is no solid phase.

4. a) 204.1 k J
   b) Temperature
   c) i) Unit cell – this is the basic arrangement of atoms or molecules in a crystal structure from which the whole structure is built.
   ii) This is the site that an atom or molecule or ion occupies in a crystal structure.
   iii) An Allotrope is a different crystal structure of the same material.
   iv) A molecular solid is a solid in which the lattice sites are occupied by molecules.

5. a) i) Hydrogen bonding
   ii) The order one would expect is that of increasing dipole moment
   $NH_3 < H_2O < HF$

iii) The actual order is a stated because water forms multiple hydrogen bonds the others do not.

b) i) $CH_4 < C_2H_6 < C_3H_8 < C_4H_{10}$

ii) They all have the same type of intermolecular force – London Dispersion – so, the boiling point will depend primarily on molecular weight.

c) i) The liquid is cooling and the atoms/molecules are loosing K.E.

ii) Here the material is super cooled – this occurs as it takes time for atoms or molecules to arrange themselves in an ordered structure needed for them to become a solid.

iii) Here we have the material freezing (solid/liquid present) and we are losing P.E.

iv) Here the material is a solid and in cooling down losing K.E.