

Name: _____

**GENERAL CHEMISTRY
CHEM. 111 SEC. 001**

EXAM I

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Spring, 2003

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. Give an explanation of two of the following:

- i) London Dispersion forces
- ii) Dipole-Dipole forces
- iii) Hydrogen Bonding forces

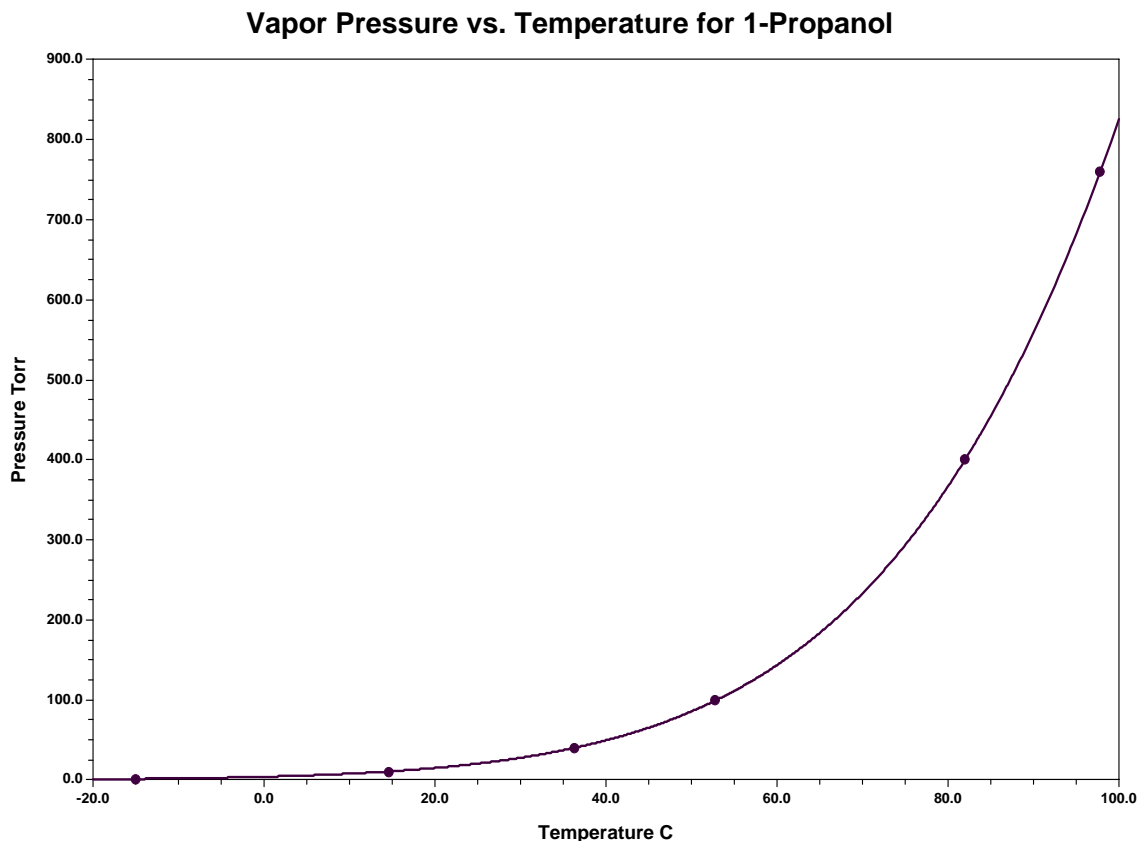
10 points

2. Explain:

- i) The difference between gases and liquids.
- ii) Why does a liquid cool when it evaporates?
- iii) The term 'Critical Temperature'.
- iv) The term 'molecular liquid'.
- v) What is meant by a 'Dynamic Equilibrium'?
- vi) Le Châtelier's Principle.
- vii) Is the system of ice cubes floating in water at 25°C a system that is an equilibrium. Explain your answer.
- viii) The average kinetic energy of atoms or molecules in a substance is a measure of what ?

32 points

3.



The above vapor pressure curve is for 1- Propanol.

- i) Give one condition of pressure and temperature under which 1-Propanol will exist only as a liquid.
- ii) Give one condition of pressure and temperature under which 1-Propanol will exist only as a gas?
- iii) For 1-Propanol to be in an equilibrium between liquid and vapor at a pressure of 250 torr, what must the temperature be?
- iv) At an atmosphere pressure of 500 torr at what temperature will 1-Propanol boil?

16 points

4. 450.0g of liquid acetone (C_3H_6O) at $10^\circ C$ is heated to $56^\circ C$ (its boiling point) and completely converted into a gas at that temperature. Given the heat capacity of acetone is $2.18 J \cdot g^{-1} \cdot ^\circ C^{-1}$ and its heat of vaporization at $56^\circ C$ is $29.1 kJ \cdot mole^{-1}$. Calculate the heat energy in kJ to do this process.

10 points

5. a) Explain the boiling points of the following compounds:

<u>Compound</u>	<u>Boiling Point °C</u>
CH ₃ CH ₂ CH ₂ CH ₃ (Butane)	-0.5
CH ₃ CH ₂ CH ₂ OH (Propanol)	97.4
CH ₃ Cl (Methyl Chloride)	-24.2

10 points

- b) Explain the boiling points of the following compounds:

<u>Compound</u>	<u>Boiling Point °C</u>
CH ₃ Cl (Methyl Chloride)	-24.2
CH ₃ Br (Methyl Bromide)	3.5
CH ₃ I (Methyl Iodide)	42.4

12 points

- c) Explain the boiling points of the following compounds:

<u>Compound</u>	<u>Boiling Point °C</u>
CH ₄ (Methane)	-164
Ammonia	-33.3
Neon	-246
Hydrogen Fluoride	19.5

10 points

ANSWERS

1.
 - i) London dispersion forces arise from the fact that as two atoms or molecules come close to one another the electron clouds repel each other forming a small temporary induced dipole. This temporary small induced dipole gives rise to a very small attraction between the atoms or molecules in the material.
 - ii) This only occurs in polar molecules. The negative end of one molecule is attracted to the positive end of another molecule.
 - iii) This occurs when hydrogen is bonded to a very small electronegative atom in a molecule. The hydrogen atom in one molecule then forms what is in reality a very, very weak bond to the small electronegative atom on another molecule.
2.
 - i) The main differences are:
 - a) In gases there is a much larger space between the atoms and molecules.
 - b) Gases will distribute themselves throughout a container, liquids will not.
 - c) Gases are very compressible, liquids are not.
 - ii) A liquid cools on evaporation. In a liquid it is the high kinetic energy molecules which escape from the liquid. Therefore the average kinetic energy of the atoms or molecules decreases. As the average kinetic energy of atoms or molecules is a measure of temperature. The temperature therefore drops.
 - iii) The 'critical temperature' is that temperature above which a material can only exist as a gas.
 - iv) A molecule liquid is a liquid which contains only molecules.
 - v) A dynamic equilibrium is an equilibrium in which on a macro scale no change appears to be take place. However, on the atom/molecule scale the system is undergoing continual change.
 - vi) Le Châtelier's Principle says that when a system in equilibrium is place under a constant/stress it will move in a direction to oppose that constraint/stress.
 - vii) No. at 25°C the ice cubes will melt so the system is changing so it cannot be in equilibrium.
 - viii) Temperature.
3.
 - i) 20°C and 500 Torr
 - ii) 80°C and 100 Torr
 - iii) ~75°C
 - iv) ~87.5°C

4. 271 kJ

5. a) The compounds have very similar molecular weights, so this cannot account for the large difference in boiling points. However, the intermolecular forces are different, butane, London Dispersion, propanol, hydrogen bonding, methylchloride, dipole-dipole. The boiling points follow the strength of the intermolecular forces.
- b) All three have similar intermolecular forces and therefore the boiling points just depend on the molecular weight.
- c) All four have similar molecule weights, so molecular weight cannot account for the differing boiling points. Methane and Neon have only London Dispersion Forces and have the lowest boiling points. In methane, however, the London Dispersion Forces are larger than in Neon, due to the species being larger and the electron cloud can be more easily distorted. Ammonia and hydrogen fluoride have hydrogen bonding and consequently have the higher boiling points. The hydrogen bonding in ammonia is weaker than that in hydrogen fluoride despite the fact that it can form multiple hydrogen bonds. Hydrogen fluoride has the highest boiling point.