

Chem 106 Exam 3. January 21, 2005.

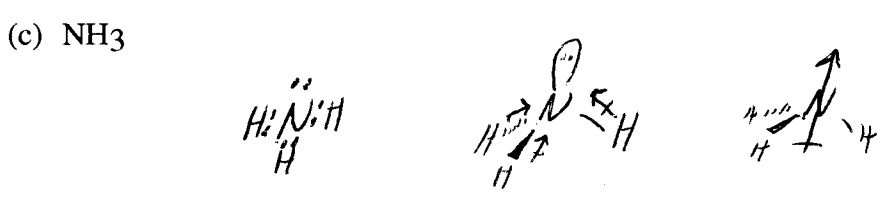
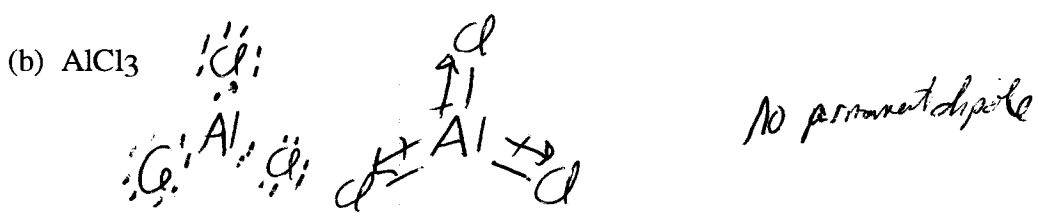
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Name Key

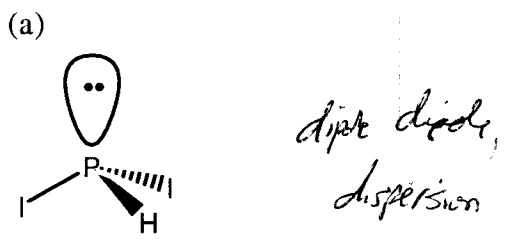
You must show all work for credit!

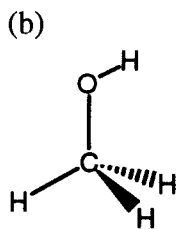
Useful Information:  $\ln \frac{P_1}{P_2} = \frac{\Delta H}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$ ,  $q = s \times m \times \Delta T$ ,  $R = 8.314 \frac{J}{mol \cdot K}$ ,  $1 atm = 760 mmHg$

(1) (6 pts) Which of the following molecules has a permanent dipole moment? Draw a three dimensional figure of each molecule and indicate the direction of the dipole moment (if it has one).

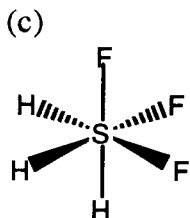


(4 points)  
 (2) List all intermolecular forces that are important for each of the following molecules.

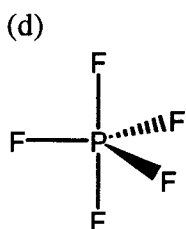




dispersion  
dipole-dipole  
H bonding



dispersion  
dipole-dipole



dispersion

(3) (7 points) Complete the table

Type of Solid	Metal	ionic	molecular	network covalent
solid conducts electricity	yes	no	no	no
liquid conducts electricity	yes	yes	no	no
particles are connected by	covalent bonds	ionic bonds	intermolecular forces	covalent bonds
soluble in nonpolar solvents	no	no	nonpolar ones are	no
soluble in polar solvents	no	yes	polar ones are	no

(4) Place the following in order of increasing boiling point.

(a) Ne

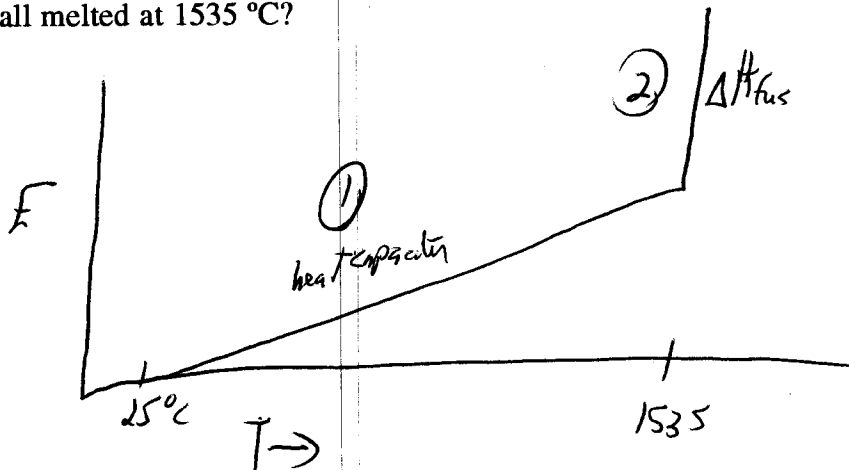
(b) CH<sub>4</sub>

(c) SF<sub>6</sub>

(d) SiI<sub>6</sub>

CH<sub>4</sub>, Ne, SF<sub>6</sub>, SiI<sub>6</sub>

- (5) <sup>60/3</sup> Iron has a melting point of 1535 °C. Its  $\Delta H_{\text{fus}} = 13.13 \text{ kJ/mol}$ . If the heat capacity for solid iron is 25.1 J/mol·K, how much energy is required to heat a 1.00 kg piece of iron <sup>from 25°C</sup> until it has all melted at 1535 °C?



$$\textcircled{1} \quad \Delta T = 1535^\circ\text{C} - 25^\circ\text{C} = 1510^\circ\text{C}$$

$$q = s \times m \times \Delta T = (25.1 \frac{\text{J}}{\text{mol}\cdot\text{K}}) (17.91 \text{ mole}) (1510^\circ\text{C})$$

$$q = 6.7 \times 10^5 \text{ J}$$

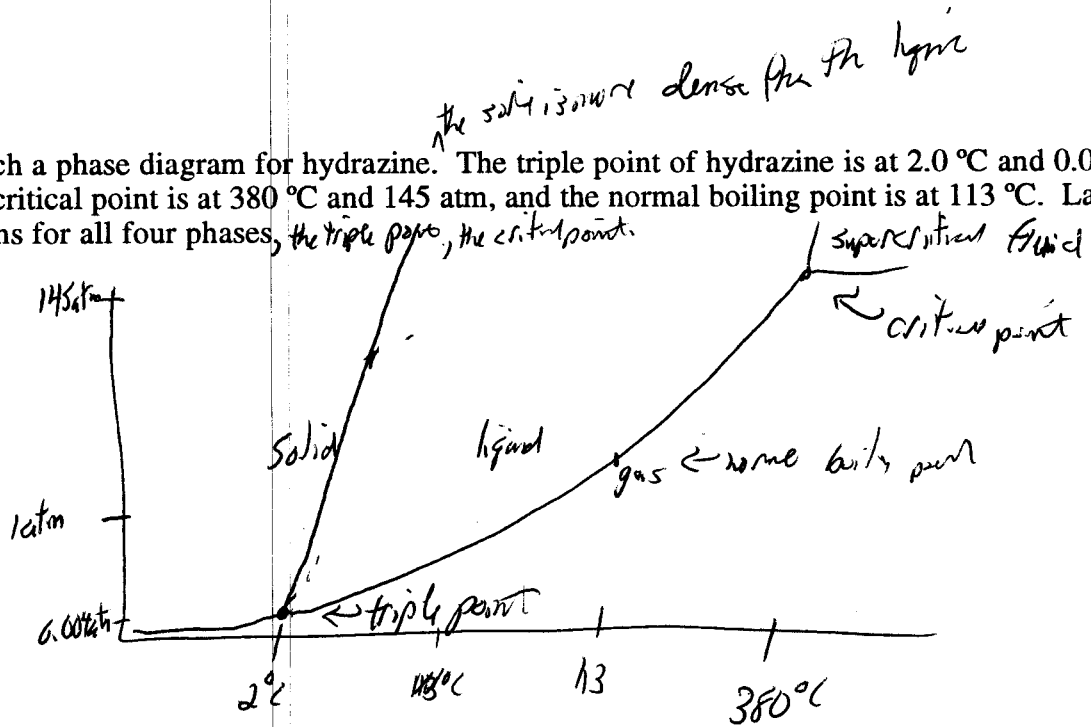
$$1000\text{g} \div 55.85 \frac{\text{g}}{\text{mole}} = 17.91 \text{ mole}$$

$$\textcircled{2} \quad (13,130 \frac{\text{J}}{\text{mole}}) (17.91 \text{ mole}) = 2.35 \times 10^5 \text{ J}$$

$$\text{total } q = 9.14 \times 10^5 \text{ J}$$

6pts

(6) Sketch a phase diagram for hydrazine. The triple point of hydrazine is at 2.0 °C and 0.004 atm, the critical point is at 380 °C and 145 atm, and the normal boiling point is at 113 °C. Label the regions for all four phases, the triple point, the critical point.



6pts

(7) Using the phase diagram from problem 6, tell if any phase changes occur when the conditions are changed as follows

(a) The temperature is raised from -50 °C to 400 °C at 1 atm of pressure

Solid → liquid & liquid to gas

(b) The pressure is raised from 1 atm to 20 atm at 420 °C

nothing

(c) The temperature is raised from 200 °C to 400 °C at ~~0.5~~ 0.004 atm of pressure.

50 °C to 400 °C at 0.5 atm & pressure

liquid to gas

(8) Chloroform,  $\text{CHCl}_3$  was once used as an anesthetic. Chloroform has a  $\Delta H_{\text{vap}}$  of 31.4 kJ/mol and a normal boiling point of 61.7 °C. What is its  $P_{\text{vap}}$  at normal body temperature, 37 °C?

$$T_1 = 61.7^\circ\text{C} = 334.7\text{K} \quad P_1 = 760\text{ mm Hg}$$

$$T_2 = 37^\circ\text{C} = 310\text{K}$$

$$\ln \frac{760\text{ mmHg}}{P_2} = \frac{31,400\text{ J/mol}}{8.314\text{ J/mol}\cdot\text{K}} \left( \frac{1}{310\text{K}} - \frac{1}{334.7\text{K}} \right)$$

$$\ln \frac{760\text{ mmHg}}{P_2} = -0.899$$

$$\frac{760\text{ mmHg}}{P_2} = 2.457$$

$$P_2 = 309\text{ mmHg}$$

(9) (8 pts) Which of the following compounds do you expect to be soluble in water? in toluene ( $\text{C}_7\text{H}_8$ )?

(a) HF water, not toluene

(b)  $\text{PF}_5$  toluene, not water

(c)  $\text{Na}_2\text{CO}_3$  water, not toluene

(d)  $\text{I}_2$  toluene, not water