Name: KEY

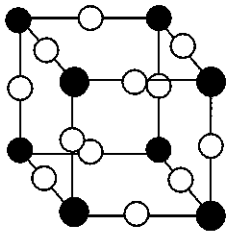
AP Practice Chemistry Test

Solids, Liquids & Phase Changes – Chapter 11 (Chang)

I. **Vocabulary** - Define the following terms.

- adhesion - attraction to other materials
- allotropes - diff. forms of the same element
- atomic solid - cryst. struct. found in metals
- boiling point - temp. @ which $P_{vap} = P_{atm}$
- Bragg Equation - used in x-ray crystallography
- capillary depression - level is lower inside tube
- capillary rise - liquid level is higher inside tube
- Clausius-Clapeyron equation - relates P_{vap} to temp (see notes)
- cohesion - a material's attraction to itself
- concave meniscus - M
- convex meniscus - M
- cubic closest packing - abc layering - FCC unit cell
- dipole-dipole attractions - attractions between two polar molecules
- enthalpy of fusion - energy needed to melt 1g of ice.
- enthalpy of vaporization - " " " boil 1g of water
- hexagonal closest packing - aba (hex. unit cell)
- hydrogen bonding - strong dipole-dipole (H w/ N O F)
- London dispersion forces - temp/induced dipole
- macromolecule - molec. large enough to see (ex. diamond)
- melting point - temp. where P_{vap} solid = P_{vap} liquid
- molecular solid - solid dependent on IMF's
- network solid - atomic solid w/ strong, dir. cov. bonds
- space lattice - 3-d arrangement of unit cells
- specific heat capacity - energy needed to raise temp. of 1g of a material 1°.
- surface tension - skin like property @ surface of liquids due to imbalanced forces
- unit cell - simplest repeating part of a crystalline structure.

1. How many net **NET** atoms are there in the unit cell shown below? (Black atoms are at the corners, white atoms are along the edges.) Write your answer in the space.



Black = $8 \times \frac{1}{8} = 1$ atoms

White = $12 \times \frac{1}{4} = 3$ atoms

NET TOTAL = 4 atoms

2. Liquid "X" exhibits greater adhesion to glass than cohesion to itself. Liquid "Y" has greater cohesion than adhesion to glass. How will these two liquids differ in terms of their respective capillary behaviors and menisci.

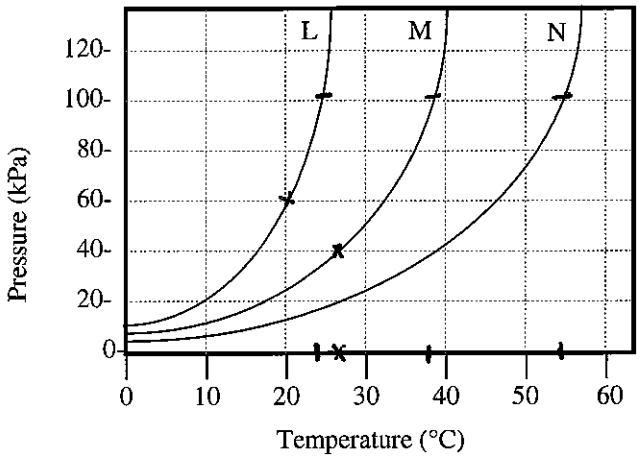
X will show capillary rise and a concave meniscus. Y, cap. depression & convex men.

3. Using the vapor pressure diagram here, estimate the normal boiling point of each liquid.

L = 23°C (± 1°C)

M = 38°C (± 1°C)

N = 54°C (± 1°C)



4. Using the above diagram estimate the temperature of boiling liquid "M" in a vacuum chamber at 40 kPa and of boiling liquid "L" at 60 kPa.

M @ 40 kPa = 27°C

L @ 60 kPa = 20°C

$\Delta H_{f ice} = 6.01$ kJ/mol
$c_{ice} = 2.03$ J/g°C
$c_{H_2O} = 4.184$ J/g°C
$c_{steam} = 1.99$ J/g°C
$\Delta H_{v water} = 40.7$ kJ/mol

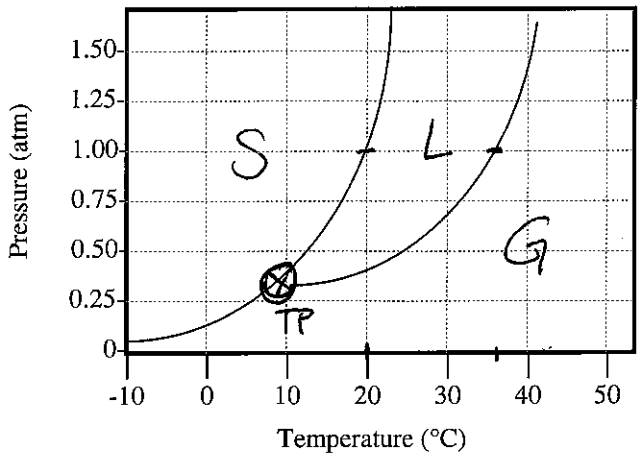
5. Describe the relationship between strength of intermolecular forces and…
As intermolec. forces increase …
- …vapor pressure at room temperature. decreases
- …normal boiling point. increases
- …enthalpy of vaporization. increases

6. Which processes release energy?

a) sublimation	c) melting	e) boiling	(g) condensation
b) vaporization	(d) freezing	f) evaporation	(h) deposition

7. Which compounds would exhibit hydrogen bonding?

(a) H_2O b) CH_4 (c) NH_3 (d) HF



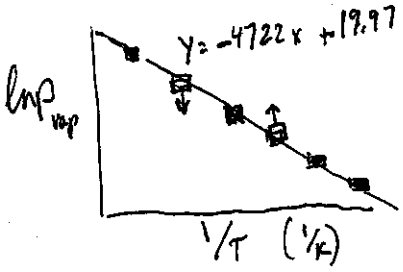
8. Label the phase diagram above to indicate solid (S), liquid (L), gas (G), and triple point (TP). Also, approximate the values for the normal melting and boiling points and the critical point.
MP = 20°C BP = 37°C CT = 41°C CP = 1.7 atm

9. What is the cell edge length of a body centered cubic unit cell for an element with an atomic radius of 97.0 pm? If this element has a density of 2.65 g/cm^3, what is its atomic mass?
$\ell = \frac{4r}{\sqrt{3}} = \frac{4 \cdot (97.0\text{pm})}{\sqrt{3}} = 224\text{ pm} = \ell$ $m = D \cdot V = (2.65\text{g/cm}^3)(2.24\times10^{-8})^3 = 2.98\times10^{-23}\text{ g} \times \frac{6.02\times10^{23}\text{ u}}{1\text{ g}} = 17.9\text{ u/uc} \div 2\text{ a/uc} = 8.97\text{ u}$

10. Determine the final temperature and physical state of a 15.2 g ice cube that starts out at -22.6°C which absorbs 8.1 kJ of energy. ② $(15.2\text{g})(6.01\text{ kJ/mol})\left(\frac{1\text{ mol}}{18.02\text{g}}\right) = 5.069$ kJ (36.2°C, liquid)
① $(15.2\text{g})(2.03\text{ J/g°C})(22.6\text{°C}) = 697.3\text{ J} = 0.6973$ kJ ① + ② = 5.771 kJ − 8.1 = 2.3 kJ = $(15.2\text{g})(4.184\text{ J/g°C})\Delta t$

10. Calculate the vapor pressure of water at 12.2°C. (HINT: Hvap = 40.7 kJ/mol. Also, use the normal boiling point and Clausius-Clapeyron.)
$\ln\left(\frac{P_1}{1\text{ atm}}\right) = \frac{40700\text{ J/mol}}{8.3145\text{ J/molK}}\left(\frac{1}{373\text{ K}} - \frac{1}{285.2\text{ K}}\right) = 4.04$ $\frac{P_1}{1\text{atm}} = \ln^{-1}(4.04) = 0.0186$ 0.018 atm

11. Use the data below to determine the enthalpy of vaporization and normal boiling point for substance "Z"; (attach a printout or sketch of your graph, including linear regression model)



Temperature (°C)	Vapor Pressure (mm Hg)
0	14.4
10	26.6
20	47.9
30	81.3
40	133
50	208

$\Delta H_{vap} = -R \cdot \text{slope} = 39.31$ kJ/mol
@ P = 760, ln P = 6.63
1/T = 0.0028 ⇒ 84°C

BONUS: Which of the following is most likely substance "Z"; water, methane, nitric acid, or diamond? Explain your choice.
BP = 100° gas at RT, so BP < 25°C