Chemistry 1066 Exam I

1. (2 pts) The principal difference in the respective normal boiling points of ICl (97ºC; molecular mass 162 amu) and Br_2 (59 ºC; molecular mass 160 amu) is mainly due to:

   a) London-dispersion forces **b. dipole-dipole interactions**

   c) hydrogen bonding

   d) both hydrogen-bonding and dipole-dipole interactions

2. (2 pts) In liquids, the attractive intermolecular forces are

   a) very weak compared with kinetic energies of the molecules

. b) strong enough to hold molecules relatively close together.

   c) strong enough to keep the molecules confined to vibrating about their fixed lattice points.

   d) not strong enough to keep molecules from moving past each other.

   e) **strong enough to hold molecules relatively close together but not strong enough to**

   keep molecules from moving past each other.

3. (2 pts) A crystalline solid will _____.

   a) have no long range regular, repeating structure

   b) always have a simple cubic structure

   c) **have a highly ordered, long range structure**

   d) have an amorphous structure

4. (4 pts) What is the minimum angle of diffraction (2Θ) expected for a cubic crystalline solid that has a lattice spacing of 478 pm when X-rays of 135 pm in wavelength are used.

a) **16.2** b) 8.12 c) 32.8 d) 21.9

5. (4 pts) In an XRD analysis using a wavelength of 165 pm a crystalline sample of a layered CoO structure gave (2Θ) peaks at 42.38º, 65.68º, and 92.60º. What is likely to be the value of the distance between the layers?

a) **456.4 pm** b) 912.8 pm

c) 122.4 pm d) 244.7 pm

6. (2 pts) Europium (Eu) crystallizes in a body-centered cubic unit cell. There will be _____ total volume(s) of Eu atoms per unit cell.

a) 1 b) **2** c) 3 d) 4 e) 5

7. (4 pts) A metal crystallizes in a face-centered cubic (FCC) unit cell with an edge length of 3.892E-10 m. What is the radius of the metal atom?

a) 168.5 pm b) 194.6 pm c) **137.6 pm**

d) 389.2 pm e) 417.0 pm

8. (3 pts) The radius of a metal is atom is 125 pm and its atomic mass is 77.223. The density of the metal is 10.66 g/cm^3. Which of the cubic crystalline structures best fits the metals size and density?

a) FCC b) **BCC** c) simple cube d) Rubik's cube

9. (3 pts) A face-centered cubic crystalline structure will have _____ tetrahedral holes within the unit cell.

a) 4 b) 6 c) **8**

d) 12 e) 2

10. (3 pts) An ionic compound crystallizes with atom X occupying all of the lattice points of a face-centered cube, atom Y occupying one-quarter of the tetrahedral holes and atom Z occupying half of the octahedral holes. What is the empirical formula of this compound?

a. **X_2YZ** b. X_2Y_4Z c. XYZ d. XY_4Z

11. (2 pts) Which of the following is an example of a network solid?

a) NaCl b) $KC_2H_3O_2$ c) **diamond**

d) calcite e) halite

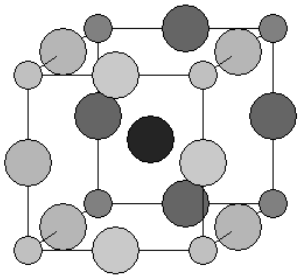
12. (3 pts) The bonding in solid-state metals can be described as

a) non-existent.
b) a covalent network.
c) **sea of valence electrons.**
d) highly directional.

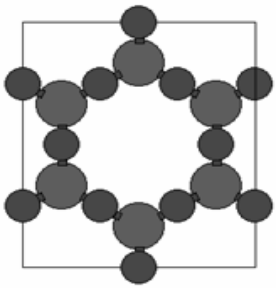
13. (2 points) What is an allotrope?

a) Sulfur crystallized in a "puckered" eight-member ring
b) A member of a family of substances with shared chemical compositions but different structures and properties
c) A different molecular form of the same element
d) A form of carbon bonded by sp^3 hybrid orbitals in such a way that each layer is independent

14. (2 points) Which of the following structures shows an amorphous solid?



A



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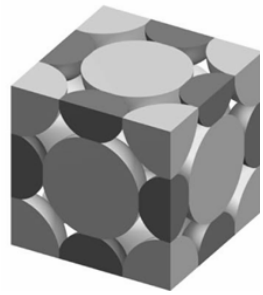

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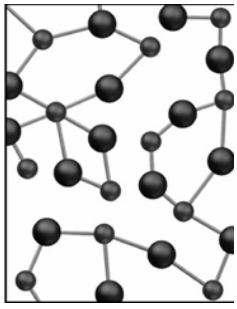

D

16. (3 points) Why are the radii of main group anions larger than the radii of their parent atoms?

a) The radii of main group anions are not larger than that of their parent atom, they are smaller
b) **The addition of valence shell electrons leads a decrease in the effective nuclear charge and thus an expanded valence shell.**
c) Electronegativity decreases when valence shell electrons are removed thus as size and electronegativity are inversely proportional, the size must go up
d) Increased shielding of the outer electrons by the inner electrons draws the inner electrons closer to the proton distorting the outer orbitals into longer shapes and increasing the size

18. (3 points) Which of the compounds below would you expect to have the highest vapor pressure if they are all at 25 ºC?

a. C_2H_5OH b. glucose c. $(CH_3)_2O$ d. **C_4H_{10}**

19. (5 points) Calculate the vapor pressure of a mixture of 19.8 g of cyclohexanone ($C_6H_{10}O$; FW=98.14) dissolved in 11.4 g of n-heptane (C_7H_{16}; FW=100.21) at 25.0 ºC. The vapor pressure of cyclohexanone and n-heptane are 4.3 and 46 torr, respectively at 25.0 ºC. [Assume no intermolecular interactions between the solvents.]

a. **19.4** b. 32.6 c. 25.2 d. 12.8 e. 17.2

20. (3 points) An aqueous solution that is 0.832 M in ethanol (CH_3CH_2OH) will have an osmotic pressure of _____ at 27.0 ºC.

a) 0.375 atm b) 31.2 atm c) 1.84 atm d) **20.5 atm**

21. (4 points) 1.75 g of an unknown non-ionic solute was dissolved in 12.0 g of water producing a solution that had a freezing point temperature of –2.45 °C. What was the molar mass of the solute?

a) 1973 b) 15.8 c) 27.7 d) 245 e) **111**

22. (3 points) A 0.972 m aqueous solution of potassium sulfate (i=2.5) would be expected to have a boiling point temperature of approximately _____ ºC.

a) **101.3** b) 112.6 c) 98.7 d) 97.4 e) 120.

23. (3 points) In an *Ideal Solution* the _____ will equal the vapor pressure of the mixture.

a. total molar mass of the solvent divided by the number of moles
b. **sum of the vapor pressures of the components of the mixture**
c. vapor pressure of the least volatile component
d. sum of the mole fractions of the components plus the molar mass

24. (2 points) Which structure has 2 atoms in the unit cell?

a) Cubic Closed Packed b) **Body Centered Cubic**

c) Simple Cubic d) Face Centered Cubic

25. (2 pts) X-rays with a wavelength of 158.0 pm scatter at an (2Θ) angle of 32.0° from a crystal.
If, n=1, what is the distance between planes of atoms in the crystal that give rise to this scattering?

a) **287** b) 149 c) 494 d) 247 e) 378

26. **Extra credit** (4 points)

The density of iron is given in one table as 7.874 g cm^{-3}. Assume that the iron crystallizes in a simple cubic unit cell with a radius of the Fe atom of 103.37 pm. Calculate Avogadro's number based on these parameters.

a) 6.0221E23 b) 6.421E23 **c) 8.027E23**

d) 1.284E25 e) 4.0721E23

Miscellaneous Information:

$n\cdot\lambda = 2\cdot d\cdot\sin\theta$ edge(simple cube)=2·r edge(fcc)=4·r/(2^0.5)

edge(bcc)=4·r/(3^0.5) $V(\text{sphere}) = (4/3)\cdot\pi\cdot r^3$

pm = 10^{-12} m $E = m\cdot c^2$ c = 2.998E8 $m\cdot s^{-1}$

$E(\text{photon}) = h\cdot\nu = h\cdot c/\lambda$ h=6.626E-34 J·s

R = 0.082057 L·atm/(mole·K) = 8.314 J/(mole·K)

N_A = 6.0221E23/mole

$w = F\cdot d$ $KE=1/2\cdot m\cdot u^2$ $\Delta E=q + w$ $\Delta E = q - P\Delta V$

$\Delta H = \Delta E + P\Delta V$ $\Delta H = q_p$ $q = n\cdot Cp\cdot\Delta T$ $q = n\cdot\Delta H(\text{change of state})$

$q = C(\text{calorimeter})\cdot\Delta T$ $\Delta H(\text{fusion, } H_2O) = 6.01$ kJ/mol

$\Delta H(\text{vaporization, } H_2O) = 40.67$ kJ/mol Cp(solid H_2O) = 37.1 J/mol°·C

Cp(liquid H_2O) = 75.37 J/mol°·C Cp(vapor H_2O) = 43.1 J/mol°·C