

Chemistry 1256 Exam I

Chemistry 153H Sample Exam I

Fall 2008

Chapters 10 & 11: Gilbert, Kirss & Davies

Name: _____

There is a periodic table and a section of miscellaneous information at the end of this exam. Show work for all problems requiring dimensional analysis, circle your answer for multiple choice questions on this test form. **NO PROGRAMABLE CALCULATORS.**

1. Ranks the following the compounds from lowest to highest lattice energy?

NaF, MgF₂, CaF₂, KF

2. Interaction energies are determined by Coulomb's law:

$$E = (2.31 \times 10^{-19} \text{ J} \cdot \text{nm}) \left(\frac{Q_1 Q_2}{d} \right)$$

The interaction energy of LiF is -1.14×10^{-18} J. What is the distance (in pm) between the Li⁺ and F⁻ ions?

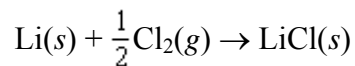
3. A sphere of hydration describes
- how molecules are solvated in water.
 - how ions are solvated in water.
 - how water dissolves molecules.
 - the shape water makes when it dissolves molecules.

4. Polarizability refers to

- the ease with which the electron cloud of an atom or molecule can be perturbed.

- b. the magnitude of the dipole moment of a molecule.
- c. the ease with which a dipole moment can polarize an atom or a molecule.
- d. the perturbation in a molecule's electron cloud due to hydrogen bonding.

5. Determine the energy change for the reaction



from the following data:

Lattice energy of LiCl = - 861 kJ/mol

Energy to vaporize Li = 159.3 kJ/mol

Ionization energy of Li = 520 kJ/mol

Cl₂ bond energy: 240 kJ/mol

Electron affinity of Cl: -349 kJ/mol

6. Which of the following compounds would you expect to be a solid at room temperature and atmospheric pressure?

- a. Kr
b. HF
c. CH₃CH₂CH₂CH₃
d. C₁₀H₈

7. Which of the following processes requires the largest net energy input?

- a. CO₂(s) → CO₂(ℓ)
b. CO₂(ℓ) → CO₂(g)
c. CO₂(s) → CO₂(g)
d. CO₂(g) → CO₂(s)

8. At the triple point of a substance:

- a. three phases are present in equilibrium.
b. the solid sublimates.
c. the gas condenses to a liquid.
d. solid and liquid are in equilibrium.

9. An aqueous solution of ammonia (NH_3) is found to have a vapor pressure of 25.5 mm Hg at 25°C . How many grams of ammonia are dissolved in 100.00 g of water? The vapor pressure of water is 25.756 mm Hg at 25°C .
10. Viscosity is a measure of a substance's _____?
- ability to resist changes in its surface area.
 - surface tension.
 - resistance to flow.
 - compressibility.

14. (5 points) If a face-centered cubic unit cell has a volume of $1.447 \times 10^8 \text{ pm}^3$ and the ions at the corners touch the ion on the face, what must be the ion's radius?

15. (5 points) Gold has a face-centered cubic structure with a unit-cell edge length of 407.8 pm. What is the calculated value of the density of gold based on this information?

16. The face-centered cubic structure is also known as _____?

- a. cubic closest-packed.
- b. hexagonal closest-packed.
- c. square closest-packed.
- d. spherical closest-packed.

17. (5 points) Aluminum has a density of 2.70 g/cm^3 and crystallizes in a *face-centered cubic* structure. What is the unit-cell edge length?
18. Glass is an example of _____?
- a. a crystalline solid.
 - b. an amorphous solid.
 - c. a liquid crystal.
 - d. a crystalline liquid.
19. The hybridization of atomic orbitals in diamond is _____.
- a. none, since it is the element.
 - b. sp .
 - c. sp^2 .
 - d. sp^3 .
20. A face-centered cubic unit cell contains a total of _____ octahedral holes.
- a. 1
 - b. 4
 - c. 8
 - d. 13
21. Compare the packing efficiency of face-centered cubic gold and face-centered cubic sodium chloride.
- a. The efficiency of packing in the gold unit cell is higher.
 - b. The efficiency of packing in the sodium chloride unit cell is higher.
 - c. The efficiencies of packing in the two lattices are the same.
 - d. There is no way to compare without further information.

22. An approximately spherical allotrope of carbon containing 60 or 70 atoms is ____?
- a. spherohexadecalene and spheroheptadecalene.
 - b. spheralene-60 and spheralene-70.
 - c. fullerene.
 - d. graphitolene.

Extra Credit. The density of pure silicon is 2.33 g/mL. What is the packing efficiency (percentage of the space inside the unit cell occupied by atoms) of the Si atoms in pure Si if the radius of one Si atom is 117 pm?

Packing efficiency (%) =

$$\frac{\text{Volume occupied by Si atoms}}{\text{volume of unit cell}} \times 100$$

Miscellaneous Information and Formulae:

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

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

$$\text{pm} = 10^{-12} \text{ m} \quad E(\text{photon}) = h \cdot \nu = h \cdot c / \lambda \quad h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$R = 0.082057 \text{ L} \cdot \text{atm} / (\text{mole} \cdot \text{K}) = 8.314 \text{ J} / (\text{mole} \cdot \text{K})$$

$$N_A = 6.0221 \times 10^{23} / \text{mole} \quad E = 2.31 \times 10^{-19} \text{ J} \cdot \text{nm} [(Q_1 \cdot Q_2) / d]$$

$$C_{\text{gas}} = K^H P_{\text{gas}} \quad P_1 = \chi_1 P_{\text{total}} \quad \pi = i \cdot M \cdot R \cdot T$$

$$\Delta T_f = i \cdot K_f \cdot m \quad \Delta T_b = i \cdot K_b \cdot m \quad K_f(\text{H}_2\text{O}) = 1.86 \text{ }^\circ\text{C}/m$$