

## WORKSHEET - SOLIDS

SetA:

1. Indicate the type of crystalline solid each of the following would form upon crystallization. Tell what type of particles (atoms, ions, polar molecules, nonpolar molecules) are located at the lattice points and the types of attractive forces between the particles.

	Type of crystalline solid	Type of particles At lattice points	Attractive forces between particles
SiC			
HBr			
Cu			
Br <sub>2</sub>			
NH <sub>4</sub> ClO <sub>3</sub>			

- 2a. Draw and label the Börn-Haber cycle for the formation of strontium chloride from strontium and chlorine.

- 2b. Write the equation for each step of the cycle and use the following constants to calculate the enthalpy for formation of strontium chloride.

Enthalpy of sublimation of strontium: +164 kJ/mole

First ionization energy for strontium: +549 kJ/mole

Second ionization energy for strontium: +1064 kJ/mole

Enthalpy of dissociation (bond energy) of chlorine, Cl<sub>2</sub>: +243 kJ/mole

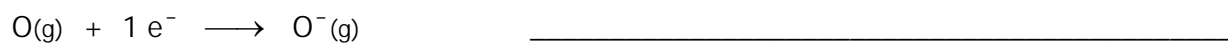
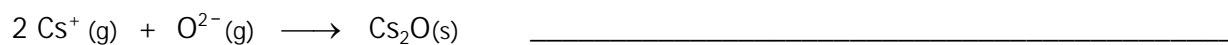
The electron affinity of chlorine, Cl: -349 kJ/mole

Lattice energy of strontium chloride: -2150 kJ/mole

Answer= -828 kJ

3. Crystalline aluminum has cubic structure. The unit edge length is  $4.05 \times 10^{-8}$  cm. The density of solid aluminum is  $2.6989 \text{ g/cm}^3$ . Calculate the number of aluminum atoms in one unit cell.  
(Answer = 4 atoms/unit cell)

4. Give the name of the constant used to calculate the energy,  $\Delta H$ , of each of the following processes:



5. The volume of a manganese atom is  $9.21 \times 10^{-24} \text{ cm}^3$ . Manganese crystallizes in a face-centered cubic system. What is the density of manganese?

Answer:  $7.33 \text{ g/cm}^3$

Set B:

1a. Draw and label the Börn-Haber cycle for the formation of calcium oxide from calcium and oxygen.

1b. Write the equation for each step of the cycle, and use the following constants to calculate the lattice energy of calcium oxide.

Heat of formation of calcium oxide:  $-636$  kJ/mole

Enthalpy of sublimation of calcium:  $+192$  kJ/mole

First ionization energy for calcium:  $+590$  kJ/mole

Second ionization energy for calcium:  $+1145$  kJ/mole

Enthalpy of dissociation (bond energy) of oxygen,  $O_2$ :  $+494$  kJ/mole

First electron affinity of oxygen, O:  $-141$  kJ/mole

Second electron affinity of O:  $+845$  kJ/mole

Answer:  $-3514$  kJ

2.  $\text{CaCl}_2$  crystallizes in a cubic lattice. The unit cell has an edge of  $4.77 \times 10^{-8}$  cm. The density of  $\text{CaCl}_2$  is  $6.80 \text{ g/cm}^3$ . How many formula units of  $\text{CaCl}_2$  are there per unit cell?

Answer: 4 formula units

3. A metal crystallizes in a face centered cubic packing structure and its density is  $9.25 \text{ g/cm}^3$ . What is the molar mass of the metal, if the volume of one atom of the metal is  $8.23 \times 10^{-24} \text{ cm}^3$ ?

Answer: 61.8 g/mole

4a. Name the five types of crystalline solids.

4b. Indicate the type of crystalline solid each of the following would form upon crystallization. Tell what type of particles (atoms, ions, polar molecules, nonpolar molecules) are located at the lattice points and the types of attractive forces between the particles.

	Type of crystalline solid	Type of particles At lattice points	Attractive forces between particles
$\text{S}_8$			
HF			
$\text{KMnO}_4$			
Ni			
Si			

SetC:

1a. Draw and label the Börn-Haber cycle for the formation of cesium oxide from cesium and oxygen.

1b. Write the equation for each step of the cycle, and use the following constants to calculate the lattice energy of cesium oxide.

Heat of formation of cesium oxide:  $-233$  kJ/mole

Enthalpy of sublimation of cesium:  $+78$  kJ/mole

First ionization energy for cesium:  $+375$  kJ/mole

Enthalpy of dissociation (bond energy) of oxygen,  $O_2$ :  $+494$  kJ/mole

First electron affinity of oxygen, O:  $-141$  kJ/mole

Second electron affinity of O:  $+845$  kJ/mole

Answer:  $-2090$  kJ

2. Nickel has a cubic unit cell. The edge of the unit cell is  $3.524 \times 10^{-8}$  cm. The density of nickel is  $8.91 \text{ g/cm}^3$
- How many nickel atoms are in the unit cell?
  - What is the radius of a nickel atom?

Answers: 2a. 4 atoms 2b.  $1.25 \times 10^{-8}$  cm

3. The volume of a metal atom is  $7.24 \times 10^{-24} \text{ cm}^3$ . The metal crystallizes in a face-centered cubic structure. The density of the metal is  $8.77 \text{ g/cm}^3$ . What is the molar mass of the metal?

Answer: 51.5 g/mole

4. Indicate the type of crystalline solid each of the following would form upon crystallization. Tell what type of particles (atoms, ions, polar molecules, nonpolar molecules) are located at the lattice points and the types of attractive forces between the particles.

	Type of crystalline solid	Type of particles At lattice points	Attractive forces between particles
NH <sub>4</sub> HSO <sub>4</sub>			
SiO <sub>2</sub>			
Si			
HCl			
Al			
I <sub>2</sub>			

5. Manganese crystallizes in a face-centered cubic system. The radius of one manganese atom is  $1.30 \times 10^{-8}$  cm. What is the density of manganese?

Answer: 7.33 g/cm<sup>3</sup>

6. Associate each of the solids: CsI, SiO<sub>2</sub>, Ni, and SiCl<sub>3</sub>H with one of the following sets of properties:

- |  |          |
|--|----------|
| a. A very hard solid subliming at 2900°C.  | a. _____ |
| b. A yellowish solid having a melting point of 40°C and is a nonconductor of electricity when molten (in the liquid state).  | b. _____ |
| c. A lustrous solid melting at about 1600°C. This substance conducts electricity in both the solid and liquid states.        | c. _____ |
| d. A white solid melting at about 700°C. This substance conducts electricity in the liquid state, but not in the solid state | d. _____ |