Chapter 11 Number 1 (11.1 – 11.4) (Unit 4) 16 April 2018

1. Which member of each pair has the highest predicted absolute entropy?

$Cl_2(g)$ or $Br_2(l)$ $Br_2(g)$ or Ba(s) $Cl_2(g)$ or Cu(s)

2a. Use the table of absolute entropies in Appendix B, pages A-8 through A-12 to calculate ΔS^o for the reaction shown. Do it like we did with ΔH^o.

$2\,S(s) + 3\,O_2(g) \rightarrow 2\,SO_3(g)$ $\Delta S^o = ?$

$31.8\ J/mol\,K \quad 205\ J/mol\,K \quad 256.6\ J/mol\,K$

$* -2\ mol \quad * -3\ mol \quad * 2\ mol$

$\Delta S = -63.6 - 615 + 513.3$

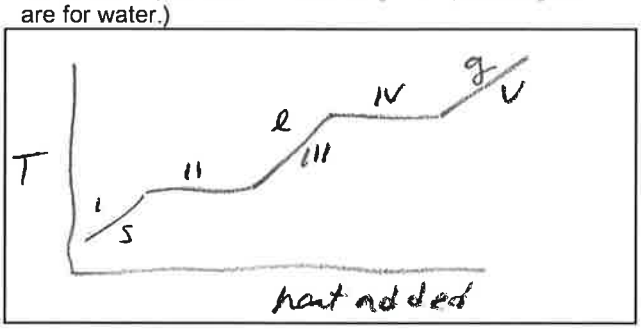
$\Delta S = -165.4\ J/K$

2b. Count the moles of reactant gases and product gases. Do the products have more or less total entropy? Is the sign of ΔS^o consistent?

$2\,S(s) + 3\,O_2(g) \rightarrow 2\,SO_3(g)$

3 mol gas → 2 mol g $\Delta S < 0$

3. Sketch a heating curve for water (see notes). Label the regions I, II, III, IV, and V like we did in class. Which value would you need for each region? (Values given are for water.)



C	Region I	A. ΔH_{fus} = 6.01 kJ/mol
A	Region II	B. ΔH_{vap} = 40.67 kJ/mol
D	Region III	C. $C_{m,\,H2O(s)}$ = 36.7 J/mol deg
B	Region IV	D. $C_{m,\,H2O(l)}$ = 75.4 J/mol deg
E	Region V	E. $C_{m,\,H2O(g)}$ = 33.6 J/mol deg

3b. What regions from the picture in Question 4 (I, II, III, IV, V) would you need to calculate the heat transferred when H_2O is...

A. Raised in temperature from -10 °C to +50 °C
Circle the regions: I II III IV V

B. Lowered in temperature from 90 °C to 50 °C
Circle the regions: I II III IV V

C. Lowered in temperature from 10 °C to -30 °C
Circle the regions: I II III IV V

D. Raised in temperature from -10 °C to +110 °C
Circle the regions: I II III IV V

E. Raised in temperature from -10 °C to -5 °C
Circle the regions: I II III IV V

3c. Which of the above situations (in Question 5) is exothermic? A B C D E

3d. How much heat is required to warm 52 g ice at -25 °C to water vapor at 120 °C? 52g = 2.89 mol

Need all 5 regions $\Delta T = 0 - -25°C$

$q_1 = 0.0367 * 2.89 * 25$ kJ = kJ

$q_2 = 6.01 * 2.89 =$ kJ $\Delta T = T_f - T_i$

$q_3 = 0.0754 * 2.89 * 100 =$ kJ

$q_4 = 40.67 * 2.89 =$ ΔT

$q_5 = .0336 * 2.89 * 20$

$\Sigma q = 161$ kJ

4. Use the Clausius-Clapyron equation (page 419) to estimate ΔH_{vap} for bromine, given that bromine has a vapor pressure of 400 mmHg at 41.0 °C and a normal boiling point of 331.9 K.

$T_1 = 314\ °C \quad T_2 = 331.9$

$P_1 = 400\ mmHg \quad P_2 = 760\ mmHg$

$\ln\left(\frac{P_1}{P_2}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$\ln\left(\frac{400}{760}\right) = \frac{\Delta H_{vap}}{8.314}\left(\frac{1}{331.9} - \frac{1}{314}\right)$

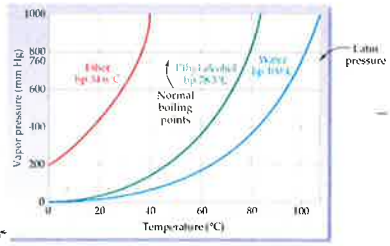
$\Delta H_{vap} = 31.1$ kJ/mol

3a. Which liquid ...

... has the highest vapor pressure at any temperature? ether

... has the highest boiling point? water

... has the strongest intermolecular forces? Water



... would evaporate the fastest in an open container? ether

3b. Estimate the boiling point of water if the external pressure is 400 mmHg? 80°C

3c. At what temperature at 1 atm one substance entirely a gas and the other two are still liquids? > 40°C

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Now try these problems from the book:

Section 11.1. (Properties of Liquids) Problem 28, 30, and 32

Section 11.2. (Phase changes) Problems 1, 2, 3, 4 and34

Section 11.3. (Evaporation, vapor pressure, boiling point) Problems 5, 6, 36, 38, 40, 42, 44, 48 and 50

Section 11.4. (Kinds of solids) Problem 58, 60 and 62

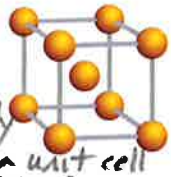
Chapter 11 Number 2 (11.4, 11.6, 11.7) (Unit 4) 18 April 2018

1. Classify each of these solids as covalent-molecular (CM), covalent-network (CN), metallic (M) or ionic (I)

A. ice	(CM)	CN	M	I
B. graphite	CM	(CN)	M	I
C. buckyball	(CM)	CN	M	I
D. zinc	CM	CN	(M)	I
E. potassium permanganate	CM	CN	M	(I)
F. silicon carbide	CM	(CN)	M	I
G. diamond	CM	(CN)	M	I

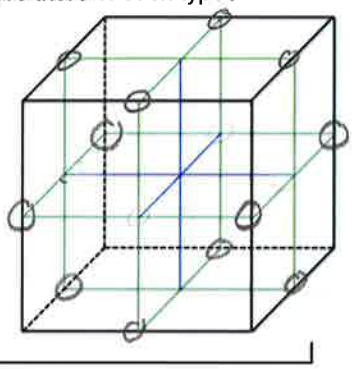
2. Identify the unit cell shown here.

A. Simple cubic
(B) Body-centered cubic
C. Face-centered cubic



most are only partially within a unit cell

3. How many actual positions are there of each type?



corner positions 8

body-center positions 1

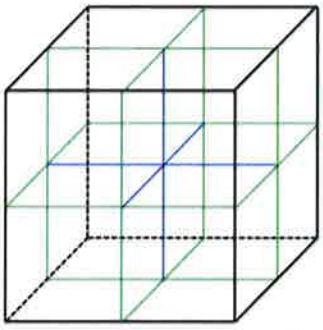
edge-center positions 12 (circled)

face-center positions 6

tetrahedral holes of a fcc lattice 8

octahedral holes of a fcc lattice 12+1 = 13

4. How many net atoms are contained within a unit cell at each of these positions?



the corners $8 \times \frac{1}{8} = 1$

the body-center one

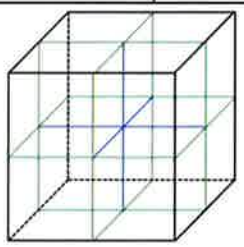
the edge-centers $12 \times \frac{1}{4} = 3$

the face-centers $6 \times \frac{1}{2} = 3$

the tetrahedral holes of a fcc lattice 8

the octahedral holes of a fcc lattice $12 \times \frac{1}{4} + 1 = 4$

5a. Lead crystallizes in a fcc unit cell with an edge length of 495 pm. What is the atomic radius of lead in pm?



for fcc

$4r = \sqrt{2}\, e$

$r = 175\ pm$

$r = 1.75 \times 10^{-8}\ cm$

5b. What is the density of lead using the information from Problem 2?

$d = \frac{m_{unit\ cell}}{V_{unit\ cell}}$

$= \frac{4\ Pb\ atoms \,|\, mol\ Pb \,|\, 207\ g}{6.02 \times 10^{23}\ atoms \,|\, mol \,|\, (4.95 \times 10^{-8}\ cm)^3}$

$= 11.15\ g/cm^3$

6. Sodium crystallizes in a body-centered unit cell and has a density of 0.968 g/cm^3. What is the atomic radius of sodium?

$d \rightarrow V \rightarrow e \rightarrow r$

$d = \frac{m}{V} \Rightarrow V = \frac{m}{d} = \frac{2\ atoms \,|\, 23\ g \,|\, cm^3}{6.02 \times 10^{23}\ atoms\ mol^{-1} \,|\, mol \,|\, 0.968\ g}$

$V = 7.89 \times 10^{-23}\ cm^3$

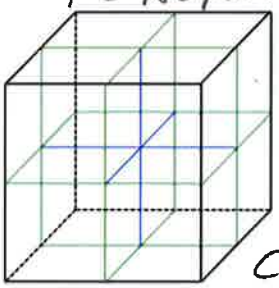
$e = 4.30 \times 10^{-8}\ cm$

$4r = \sqrt{3}\, e$

$r = 186 \times 10^{-8}\ cm$

$r = 186\ pm$

7. Cesium chloride crystallizes with chloride ions in a simple cube unit cell. The cesium ions occupy the body-centered positions. How many of each ion are present within each unit cell? Does this match the predicted formula for cesium chloride?

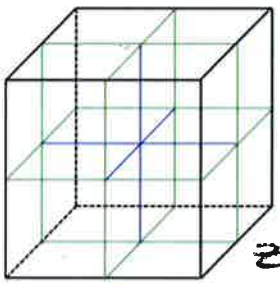


one Cl^-

one Cs^+

CsCl

8. Sphalerite is a salt of zinc cations and sulfide anions. Sphalerite crystallizes with sulfides forming a fcc sublattice and the zinc ions filling half of the tetrahedral holes. How many of each ion are present within each unit cell? What is the predicted formula for this salt?

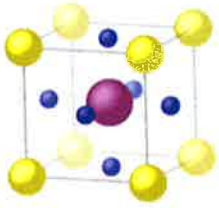


one S^{2-}

one Zn^{2+}

ZnS

9. The yellow spheres in this figure are oxygen ions, the small blue ones are sodium ions, and the large purple one is an ion of atom X. (a) What is the formula of the substance in format $Na_?X_?O_?$? (b) What is the charge on X?



Na_2XO

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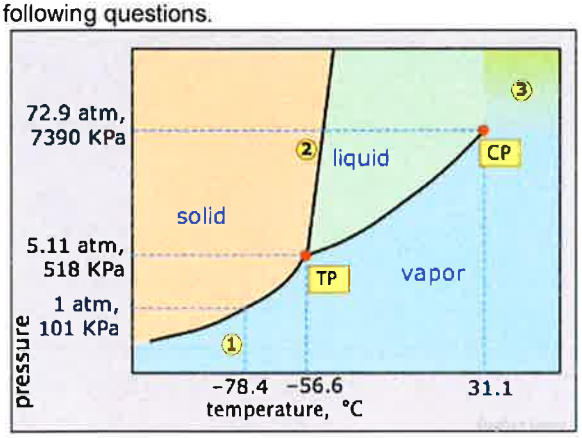
Now try these problems from the book:

Section 11.6. (Unit cells) Problem 9, 10, 11, 12, 68, 70, 74, 80, and 108

Section 11.7. (Structures of ionic solids) Problems 13, 14, 76, 78, 112, and 113 (Answ: NbO)

Chapter 11 Day 3 (Sections 11.8 – 11.9) 20 April 2018

1. Consider the phase diagram for CO_2 to answer the following questions.



1a. What is the phase of CO_2 at 1 atm and -80 °C? Solid

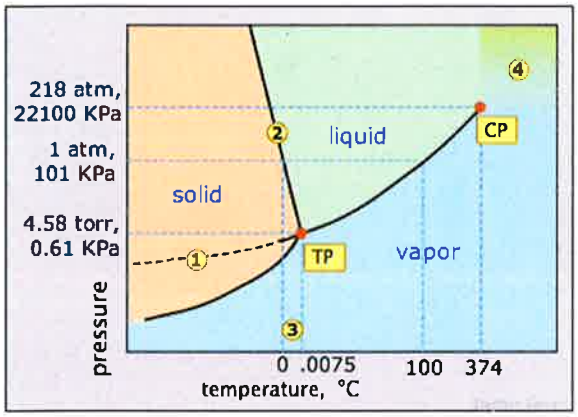
1b. What phase change, if any, occurs if CO_2 at 1 atm and 0 °C is compressed to a pressure of 50 atm? g → l

1c. What phase equilibrium exists along the line between the blue region and the green region? Write out the answer with a chemical equation.

$CO_2(l) \rightleftarrows CO_2(g)$ or other way around

1d. Is CO_2 a condensable gas at room temperature? Yes

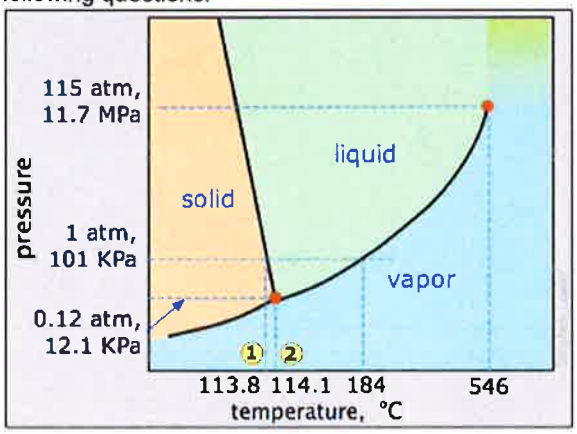
2. Consider the phase diagram for H_2O to answer the following questions.



2a. What phase change happens to H_2O at 1 atm and -10 °C if the pressure is increased? s → l

2b. What phase change happens to H_2O at 1 atm and -10 °C if the temperature is increased to 110 °C? s → l → g

3. Consider the phase diagram for I_2 to answer the following questions.

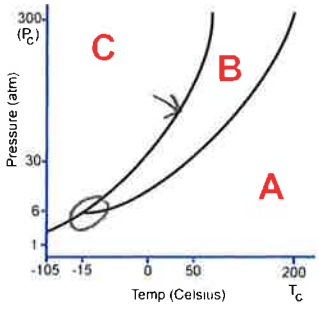


3a. What is the phase of I_2 at 1 atm and 25 °C? Solid

3b. What line represents sublimation? Answer: The line between the colored regions ___ and ___. orange & blue

3c. Which of the three substances investigated so far in this worksheet, CO_2, H_2O or I_2 has the highest critical temperature? I_2

4. Use the phase diagram here to answer the following questions.



4a. What phase is this substance under standard conditions? Circle: SOLID or LIQUID or GAS

4b. This substance is a solid at:
(A.) 30 atm, -50 °C
B. 30 atm, +50 °C
C. 30 atm, +25 °C
D. 300 atm, 250 °C

4c. Circle the triple point.

4d. Draw an arrow pointing to the solid-liquid interface.

4e. What is the critical temperature? 200 °C

4f. Is the solid phase more dense than the liquid phase? Circle: YES or NO

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Now try these problems from the book:
Section 11.9. (Phase diagrams) Problem 15, 16, 26, 82, 84, 86, 88, 90, 92, and 106.