Chapter 12 Worksheet 2

Name: Answer Key

UGA myID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname).
- Your UGA myID is a combination of letters and numbers (example: mine is aw00285). **Do not use your 81x number.**
- If you do not have a printer, type your answers in the boxes then upload the worksheet template to Gradescope by Sunday, January 24th at 11:59 p.m. Write your work on separate sheets of paper, convert to a PDF and upload to the dropbox on eLC.
- If you have a printer download the worksheet, write your answers and show your work on the worksheet template, convert it to a PDF and upload to Gradescope by Sunday, January 24th at 11:59 p.m.

Chapter 12 (Cont.)

Question 1: Which of the following processes is endothermic? (Select all that apply, enter options separated by columns).

endothermic : system absorbs heat from surroundings.

A, D

A. Evaporation of ammonia
B. Freezing of water
C. Condensation of Ammonia
D. Sublimation of CO_2
E. Deposition of CO_2

Question 2: Which of the following pure substances has the highest freezing point?

C

A. CH_3OCH_3 — polar — A. dipole - dipole, dispersion
B. CH_4 — B. dispersion only
C. H_2O — C. H-bonding, dipole - dipole, dispersio
D. CH_3Cl — D. dipole - dipole, dispersion
E. HCl — E. dipole - dipole, dispersion.

Question 3: The vapor pressure of liquid bromine at room temperature is 168 torr. Suppose that bromine is introduced drop by drop into a closed system containing air at 775 torr and room temperature. (The volume of liquid bromine is negligible compared to the volume of the system.)

A) If the bromine is added until no more vaporizes and a few drops of liquid are present in the flask, what would be the total pressure?

$P_{total} = P_{Br} + P_{closed\text{-}system}$

$= 168 \text{ torr} + 775 \text{ torr}$

943 torr

B) What would be the total pressure if the volume of this closed system were decreased to one half its original value at the same temperature?

$P_1 V_1 = P_2 V_2$, $V_2 = \frac{1}{2} V_1$

$P_2 = \frac{P_1 V_1}{V_2} = \frac{P_1 V_1}{\frac{1}{2} V_1} = 2 P_1 = 1550 \text{ torr}$

1718 torr

$P_{total} = 1550 \text{ torr} + 168 \text{ torr} = 1718 \text{ torr}$

Clausius - Clapeyron Equation ; $R = 0.008314\ \frac{kJ}{mol \cdot K}$

Question 4: At 10.0 °C, the vapor pressure of nitric acid is 26.6 mm Hg, and at 50.0 °C, the vapor pressure is 208 mm Hg. Using this information, calculate the heat of vaporization (ΔH_{vap}) of nitric acid. (The unit to report is shown to the right of the box). $T_1 = 283.15\ K$, $T_2 = 323.15\ K$

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

$\ln\left(\frac{208}{26.6}\right) = -\frac{\Delta H_{vap}}{0.008314}\left(\frac{1}{323.15} - \frac{1}{283.15}\right)$

$0.01709 = (-\Delta H_{vap}) \cdot (-0.000437)$

$\Delta H_{vap} = 39.1$ kJ/mol

Question 5: Ethanol has an enthalpy of vaporization of 42.3 kJ/mol. The compound has a vapor pressure of 1.00 atm at 78.3 °C. At what temperature is the vapor pressure equal to 0.800 atm? (R = 8.3145 J/K · mol) (The unit to report is shown to the right of the box).

$\ln \frac{0.800}{1.00} = -\frac{42.3}{0.008314}\left(\frac{1}{T_2} - \frac{1}{351.15}\right)$

$0.00004848 = \frac{1}{T_2} - 0.00285$

$0.002906 = \frac{1}{T_2}$ $\Rightarrow$ $T_2 = 345.95\ K$

$T_2 = 72.9$ °C

Question 6:
A bottle is filled with a small amount of a volatile liquid and sealed. Sometime later it is observed that no liquid is evident in the sealed bottle. Which of the following statements would explain this observation?

E

A. More time is needed to establish equilibrium.
B. Liquid and vapor are at equilibrium in the bottle.
C. The vapor state is favored when equilibrium is established.
D. The liquid has undergone sublimation.
E. Too little liquid was added to achieve a liquid vapor equilibrium in the closed system.

$T = 348\ K$, $P_{vapor} = 0.380\ atm$

Question 7: At 75.0 °C, water has an equilibrium vapor pressure of 289.1 mm Hg. If 4.22 g H_2O is sealed in an evacuated 5.00 L flask and heated to 75.0 °C, what mass of H_2O will be found in the gas phase when liquid-vapor equilibrium is established? Assume any liquid remaining in the flask has a negligible volume. (R = 0.082057 L·atm/mol·K, 1 atm = 760 mm Hg)

A

A. 1.20 g
B. 4.22 g
C. 2.64 g
D. 3.02 g
E. 0.240 g
F. None of these.

$P_{vapor} \cdot V = n_{vapor} \cdot R \cdot T$

$n_{vapor} = \frac{(0.380)(5.00)}{(0.08314)(348)} = 0.0657$

$m_{vapor} = 0.0657 \times 18.02 = 1.18$

~ MM of wate

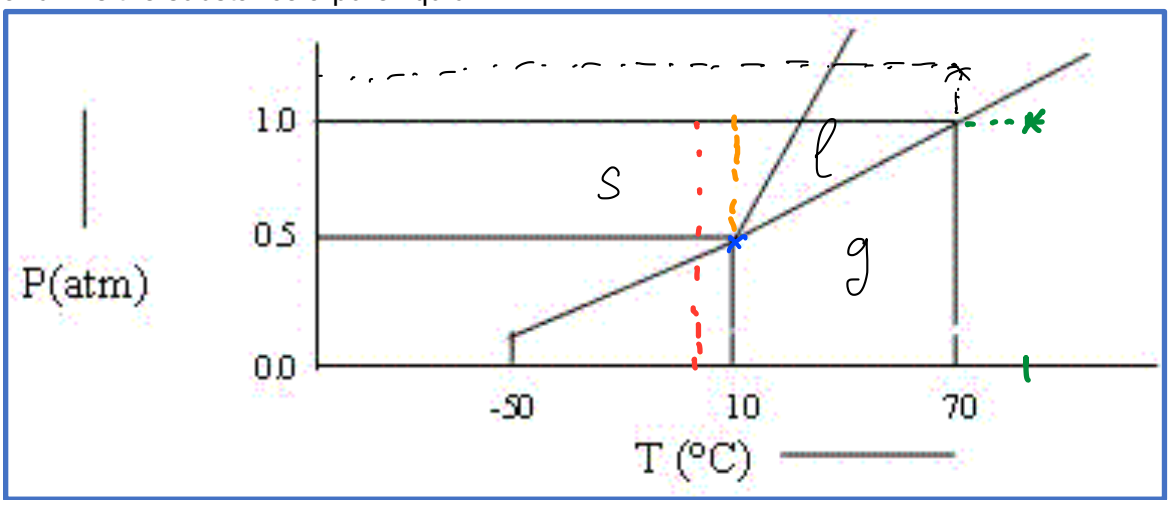
Question 8: Among the options shown, which chemical formula is paired up with an INCORRECT crystal type? Select all that apply.

B, C

A. Ni, metallic
B. Xe, metallic
C. Sn, molecular
D. Cholesterol ($C_{27}H_{45}OH$), molecular
E. SiC, network covalent
F. KCl, ionic
G. IF_7, molecular
H. C(diamond), network covalent

atomic => metallic

Question 9: A certain substance has the phase diagram shown below. At which of the following values of *T* and *P* is the substance a pure liquid?



A

A. T = 70 °C, P = 1.2 atm
B. T = 8 °C, P = 1 atm
C. T = 10 °C, P = 0.5 atm
D. T = 80 °C, P = 1 atm
E. T = 10 °C, P = 1 atm

LiBr => ionic (stronger IMFs)

Question 10: Choose the response that lists the member of each of the following pairs that has the *lower* boiling point.

i. H_2O or LiBr
ii. HF or HCl
iii. CH_3CH_3 and HO-CH_2CH_2-OH

B

A. H_2O,HF, CH_3CH_3
B. H_2O,HCl, CH_3CH_3
C. H_2O,HF, HO-CH_2CH_2-OH
D. LiBr, HCl, HO-CH_2CH_2-OH
E. LiBr,HF, HO-CH_2CH_2-OH

i. H_2O : dipole-dipole, dispersion, H-bonding

ii. HF stronger IMFs due to H-bonding.

iii. H-O-CH_2CH_2-OH has stronger attractions due to H-bonding.

Question 11: What quantity of heat is required to melt 500 g of ice at 0°C and then to heat the resulting water to steam at 100°C? Heat of fusion of ice = 333 J/g; Specific heat of water = 4.184 J/g·K; Heat of vaporization = 2260 J/g. (Report your answer using scientific notation. The unit to use is shown to the right of the box.)

$q_{fus} = 500 \times 333 = 166,500$

$q_{heat} = 500 \times 4.184 \times (100 - 0)$

$= 209,200$

1.51×10^6 J

$q_{fus} + q_{heat} + q_{evap} = q_{tot}$

$q_{evap} = 1,130,000$

$q_{tot} = 166,500 + 209,200 + 1,130,000 = 1,505,700$

Question 12:
Which has the largest temperature change, melting 100. g of ice or converting 100. g of water to steam?

C

A. Melting 100. g of ice
B. Evaporating 100. g of water
C. They're the same

Heat of Fusion for water = 333 J/g
Heat of Vaporization for water = 2256 J/g

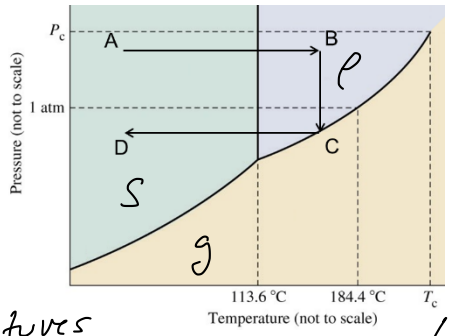
$q_{evap} = 100 \times 2256 = 225,600$ J.

$q_{fus} = 100 \times 333 = 33,300$ J.

Question 13: To the right is the phase diagram for iodine. Which of the following transitions occur when the temperature and pressure conditions are changed from A to B to C to D?

D

A. l → s → g → l
B. s → l → g → s
C. g → s → l → g
D. s → l → g → l → s
E. s → g → l → g → s

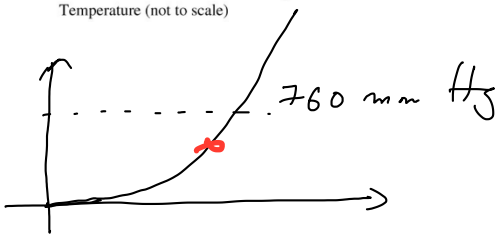


lower Pvap, lower temperatures

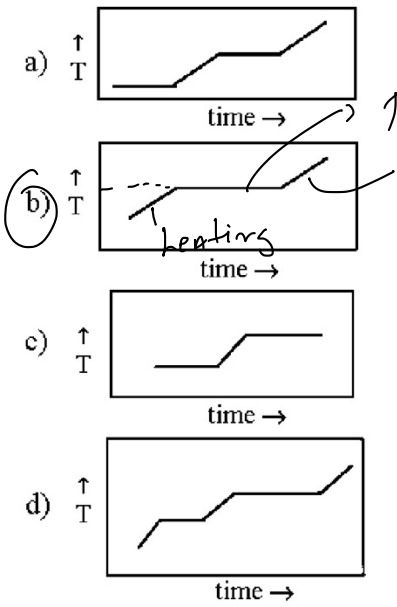
Question 14: At high altitudes, the boiling point of water is

B

A. 100 degrees Celsius.
B. less than 100 degrees Celsius.
C. greater than 100 degrees Celsius.
D. equal to its freezing point.



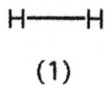
Question 15: Consider a compound that undergoes sublimation at 125°C and a pressure of one atm. Which of the following could be a heating curve appropriate for heating the compound from 100°C to 150°C?



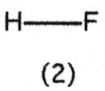
phase-transition (125°)
heating (125° - 150°C)

A. graph a)
B. graph b)
C. graph c)
D. graph d)

Question 16: Which drawing best represents hydrogen bonding?



(1)



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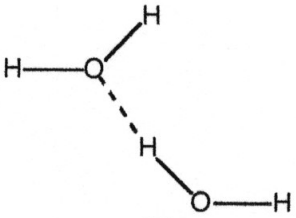

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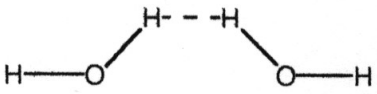

(4)

$d = \frac{m}{V}$

100 cm = 1 m

1 gram = 6.022×10^{23} amu

1 m = 10^{12} pm

C

A. drawing (1)
B. drawing (2)
C. drawing (3)
D. drawing (4)
E. None of these.

1 cm = 10^{10} pm

bcc : 2 atoms

$m_{RS} = 85.5$ amu

$m_{unit-cell} = 171$ amu

$d_{unit-cell} = \frac{\text{mass unit cell}}{\text{volume of unit cell}}$, $V = \frac{m_{unit-cell}}{d_{unit-cell}}$

Question 17: The metal rubidium crystallizes in a body-centered cubic lattice. If the density of rubidium is 1.53 g/cm^3, what is the atomic radius of rubidium?

F

A. 134 pm
B. 196 pm
C. 56 pm
D. 169 pm
E. 246 pm

$d_{unit-cell} = 1.53 \frac{g}{cm^3} \times \frac{6.022 \times 10^{23} \text{ amu}}{g} \times \frac{1 \text{ cm}^3}{(10^{10})^3 \text{ pm}^3}$

$d_{unit-cell} = 9.21 \times 10^{-7} \frac{\text{amu}}{\text{pm}^3}$, $V_{unit-cell} = 1.86 \times 10^8 \text{ pm}^3$

$V_{unit-cell} =$

$a = V^{1/3} = 570.5$ pm

$r = \frac{a\sqrt{3}}{4} \approx 247$ pm

Question 18: A metal crystallizes in a face-centered cubic lattice. The radius of the atom is 125 pm and the density of the element is 8.91 g/cm^3. What is the volume of the unit cell?

D

A. 1.95×10^6 pm^3
B. 3.27×10^7 pm^3
C. 1.12×10^9 pm^3
D. 4.42×10^7 pm^3
E. 8.18×10^6 pm^3

fcc : $a = \sqrt{8} \cdot r$

$a = 125\sqrt{8} = 353.55$ pm

$V = a^3 = (353.55)^3 = 44194173.8 \text{ pm}^3$

$= 4.42 \times 10^7 \text{ pm}^3$

Question 19 : Aluminium crystallizes with a face-centered cubic unit cell. The radius of aluminum atom is 143 pm. Calculate the density of solid crystalline aluminum in g/cm^3.

2.71 g/cm^3.

fcc : 4 atoms, $a = (\sqrt{8}) \cdot r_{atom}$

$m_{unit-cell} = (4)(26.98) = 107.92$ amu

$a = 143\sqrt{8} = 404.5$ pm, $V_{unit-cell} = 6.62 \times 10^7 \text{ pm}^3 = 6.62 \times 10^{-23} \text{ cm}^3$

$m_{unit-cell} = (107.92 \text{ amu}) \times \left(\frac{1 \text{ g}}{6.022 \times 10^{23} \text{ amu}}\right)$

Question 20: Barium is packed as a body-centered cubic unit cell and a density of 3.62 g/cm^3. What is the atomic radius of Barium? (Volume of a sphere: $V = 4/3\ \pi r^3$). (The unit to report is to the right of the fillable box.)

Strategy: ~~1 2~~ INCORRECT (you know the unit cell)

Density → Volume of Ba Metal → Volume of Ba atoms → Volume 1 Ba atom → Radius (cm) of Ba

2.2×10^{-8} cm.

$d = \frac{107.92}{(6.62 \times 10^{-23})(6.022 \times 10^{23})} = \frac{107.92}{39.87} = 2.71 \text{ g/cm}^3$

Strategy : $d = \frac{\text{Mass (bcc)}}{\text{Volume (bcc)}}$, $V = a^3$, $a = V^{1/3}$, $r = (a\sqrt{3}/4)$