Name Key SS#

Quiz 2 CHM 1046 May 16, 2002

Useful information:

$\ln P_2 = \ln P_1 + (\Delta H_{vap}/R)(1/T_1 - 1/T_2)$

$1.00 \text{ amu} = 1.66 \times 10^{-27}$ kg

$N_A = 6.02 \times 10^{23}$

$1.00 \text{ pm} = 1.00 \times 10^{-12}$ m

$R = 8.314$ J/(K mol)

$V_{cube} = l^3$; $V_{shpere} = (4/3)\pi r^3$

1. At 41°C, the vapor pressure of a liquid is 400.0 mmHg. The enthalpy of vaporization is 31.4 kJ/mol. Calculate the normal boiling point of this liquid. (Show all of your work in a logical fashion to receive full credit.)

$P_1 = 400.0 \text{ mmHg}$ $P_2 = 760 \text{ mmHg}$ $\Delta H_{vap} = 31.4 \times 10^3 \frac{J}{mol}$

$T_1 = 41°C = 314 K$ $T_2 = ?$

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

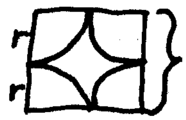
$$\frac{\ln\left(\frac{760 \text{ mmHg}}{400 \text{ mmHg}}\right)}{\frac{31.4 \times 10^3 \frac{J}{mol}}{8.314 \frac{J}{K \cdot mol}}} - \frac{1}{314 K} = -\frac{1}{T_2}$$

$T_2 = 332 K$

$= 59°C$

2. An element has an atomic mass of 296 amu. It crystallizes in a primitive cubic cell with an edge length of 380 pm.

A. Calculate the diameter of an atom of this element in pm.



$l = 2r = d \Rightarrow d = 380 pm$

B. Calculate the density of this element in g/mL.

in each unit cell (primitive cubic) $\Rightarrow$ 1 atom (Each cell is a cube)

$$m = (1 \text{ atom})\left(\frac{296 \text{ amu}}{1 \text{ atom}}\right)\left(\frac{1.66 \times 10^{-24} g}{1 \text{ amu}}\right) = 4.91 \times 10^{-22} g$$

$$V = (380 \text{ pm})^3 \left(\frac{1 \times 10^{-10} cm}{1 \text{ pm}}\right)^3 = 5.49 \times 10^{-23} cm^3 = 5.49 \times 10^{-23} mL$$

$$d = \frac{m}{V} = \frac{4.91 \times 10^{-22} g}{5.49 \times 10^{-23} mL} = 8.95 \text{ g/mL}$$

C. Calculate the packing efficiency of this element in %.

$$\% = \frac{V_{atoms}}{V_{cell}} \times 100\% = \frac{(4/3 \, \pi r^3)(1 \text{ atom})}{(2r)^3} \times 100\% = 52.3\%$$