Chapter 9 − Problems 2, 6, 18

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2. Benzene, a known carcinogen, was once widely used as a solvent. A sample of benzene vapor in a flask of constant volume exerts a pressure of 325[mmHg] at 80[°C]. The flask is slowly cooled.

   (a) Assuming no condensation, use the ideal gas law to calculate the pressure of the vapor at 50[°C]; at 60[°C]

$$\begin{aligned} P_{50[^\circ\text{C}]} &= \frac{273+50}{80+273} \cdot 325 = 297[\text{mmHg}] \\ P_{60[^\circ\text{C}]} &= \frac{60+273}{80+273} \cdot 325 = 307[\text{mmHg}] \end{aligned} \tag{1}$$

   (b) Compare your answers in (a) to the equilibrium pressure of benzene: 269[mmHg] at 50[°C], 389[mmHg] at 60[°C]

$$\begin{aligned} 297[\text{mmHg}] &> 269[\text{mmHg}] \\ 307[\text{mmHg}] &< 389[\text{mmHg}] \end{aligned} \tag{2}$$

   (c) On the basis of your answers to (a) and (b), predict the pressure exerted by the benzene at 50[°C], at 60[°C]

$$\begin{aligned} P_{50[^\circ\text{C}]} &= 269[\text{mmHg}] \\ P_{60[^\circ\text{C}]} &= 307[\text{mmHg}] \end{aligned} \tag{3}$$

6. *p*-Dichlorobenzene, $C_6H_4Cl_2$, can be one of the ingredients in mothballs. Its vapor pressure at 20[°C] is 0.40[mmHg]

(a) How many milligrams of $C_6H_4Cl_2$ will sublime into an evacuated 750[mL] flask at 20[°C]?

$$\begin{aligned} n &= \frac{.75 \cdot .0005}{.0821 \cdot 293} \\ &= .0000164[\text{mol}] \\ .0000164 \cdot 146 &= 2.4[\text{mg}] \end{aligned} \tag{4}$$

(b) If 5[mg] of *p*-Dichlorobenzene were put into an evacuated 750[mL] flask, how many milligrams would remain in the solid phase?

$$5 - 2.4 = 2.6[\text{mg}] \tag{5}$$

(c) What is the final pressure in an evacuated 500[mL] flask at 20[°C] that contains 2[mg] of *p*-Dichlorobenzene? Will there be any solid in the falsk?

$$\begin{aligned} \frac{.0000137 \cdot .0821 \cdot 293}{.5} \cdot 760 &= .5[\text{mmHg}] \\ \text{The vapor pressure is: } .4[\text{mmHg}] & \\ \text{There will be solid} & \end{aligned} \tag{6}$$

18. Consider the phase diagram of the compound X. Use the phase diagram to answer the following questions.

(a) What is the physical state of the compound at 35[mmHg] and 120[°C]?

Vapor

(b) What is the normal freezing point of the compound?

20[°C]

(c) What is the point A called?

Liquid

(d) What is the point B called?

Triple Point

(e) What is the point C called?

Normal Boiling Point

(f) What change occurs when, at a constant pressure of 33[mmHg], the temperature is decreased from 40[°C] to −20[°C]?

Deposition (Vapor to Solid)

(g) Will the solid float on the liquid?

No

(h) Can the compound exist as a liquid at 180[°C] and 2[ATM]?

Yes