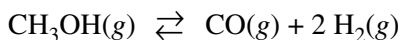


**2011 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)**

2. An 8.55 mol sample of methanol,  $\text{CH}_3\text{OH}$ , is placed in a 15.0 L evacuated rigid tank and heated to  $327^\circ\text{C}$ . At that temperature, all of the methanol is vaporized and some of the methanol decomposes to form carbon monoxide gas and hydrogen gas, as represented in the equation below.



- (a) The reaction mixture contains 6.30 mol of  $\text{CO}(g)$  at equilibrium at  $327^\circ\text{C}$ .
- (i) Calculate the number of moles of  $\text{H}_2(g)$  in the tank.
  - (ii) Calculate the number of grams of  $\text{CH}_3\text{OH}(g)$  remaining in the tank.
  - (iii) Calculate the mole fraction of  $\text{H}_2(g)$  in the tank.
  - (iv) Calculate the total pressure, in atm, in the tank at  $327^\circ\text{C}$ .
- (b) Consider the three gases in the tank at  $327^\circ\text{C}$ :  $\text{CH}_3\text{OH}(g)$ ,  $\text{CO}(g)$ , and  $\text{H}_2(g)$ .
- (i) How do the average kinetic energies of the molecules of the gases compare? Explain.
  - (ii) Which gas has the highest average molecular speed? Explain.
- (c) The tank is cooled to  $25^\circ\text{C}$ , which is well below the boiling point of methanol. It is found that small amounts of  $\text{H}_2(g)$  and  $\text{CO}(g)$  have dissolved in the liquid  $\text{CH}_3\text{OH}$ . Which of the two gases would you expect to be more soluble in methanol at  $25^\circ\text{C}$ ? Justify your answer.