|  |  |
| --- | --- |
| Time  (hours) | Total Pressure of Gases in Container at 1,160 K (atm) |
| 0.0 | 5.00 |
| 2.0 | 6.26 |
| 4.0 | 7.09 |
| 6.0 | 7.75 |
| 8.0 | 8.37 |
| 10.0 | 8.37 |

Solid carbon and carbon dioxide gas at 1,160 K were placed in a rigid 2.00 L container, and the reaction represented below occurred. As the reaction proceeded, the total pressure in the container was monitored. When equilibrium was reached, there was still some C(*s*) remaining in the container. Results are recorded in the table.

C(*s*) + CO2(*g*) ⇄ 2CO(*g*) 2008 1

a) Write the expression for the equilibrium constant, *Kp* , for the reaction. *(1pt)*

b) Calculate the number of moles of CO2(*g*) initially placed in the container.

(Assume that the volume of the solid carbon is negligible.) *(2pts)*

c) For the reaction mixture at equilibrium at 1,160 K, the partial pressure of the CO2(*g*) is 1.63 atm. Calculate

i) the partial pressure of CO(*g*) , and *(1pt)*

ii) the value of the equilibrium constant, *Kp* . *(2pt)*

d) If a suitable solid catalyst were placed in the reaction vessel, would the final total pressure of the gases at equilibrium be greater than, less than, or equal to the final total pressure of the gases at equilibrium without the catalyst? Justify your answer. (Assume that the volume of the solid catalyst is negligible.)

In another experiment involving the same reaction, a rigid 2.00 L container initially contains 10.0 g of C(*s*), plus CO(*g*) and CO2(*g*), each at a partial pressure of 2.00 atm at 1,160 K.

e) Predict whether the partial pressure of CO2(*g*) will increase, decrease, or remain the same as this system approaches equilibrium. Justify your prediction with a calculation. *(2pts)*

The compound butane, C4H10 , occurs in two isomeric forms, *n*-butane *(normal straight chain)* and isobutane

(2-methylpropane). Both compounds exist as gases at 25°C and 1.0 atm. 2010 B 1

a) Draw the structural formula of each of the isomers (include all atoms). Clearly label each structure. *(2pts)*

b) On the basis of molecular structure, identify the isomer that has the higher boiling point. Justify your answer.

*(1pt)*

The two isomers exist in equilibrium as represented by: *n*-butane (*g*) ←→  isobutane (*g*) *Kc* = 2.5 at 25°C

Suppose that a 0.010 mol sample of pure *n*-butane is placed in an evacuated 1.0 L rigid container at 25°C.

c) Write the expression for the equilibrium

constant, *Kc*, for the reaction. *(1pt)*

*(Use the compound names in the expression*

*since the formula is the same.)*

d) Calculate the initial pressure in the container

when the *n*-butane is first introduced

(before the reaction starts). *(1pt)*

e) The *n*-butane reacts until equilibrium has been established at 25°C.

i) Calculate the total pressure in the container at equilibrium. Justify your answer. *(1pt)*

ii) Calculate the molar concentration of each species at equilibrium. *(2pts)*

iii) If the volume of the system is reduced to half of its original volume, what will be the new concentration of *n*-butane after equilibrium has been reestablished at 25°C ? Justify your answer. *(1pt)*

Suppose that in another experiment a 0.010 mol sample of pure isobutane is placed in an evacuated 1.0 L rigid container and allowed to come to equilibrium at 25°C.

f) Calculate the molar concentration of each species after equilibrium has been established. *(1pt)*

A rigid container holds a mixture of graphite pellets (C*(s)*), H2O*(g)*, CO*(g)*, and H2*(g)* at equilibrium. 1998 7

C*(s)*  + H2O*(g)* ↔ CO*(g)* + H2*(g)* Δ*Hº* = +131kJ

State whether the number of moles of CO*(g)* in the container will increase, decrease, or remain the same after each of the following disturbances is applied to the original mixture. For each case, assume that all other variables remain constant except for the given disturbance. Explain each answer with a short statement. *(1pt each)*

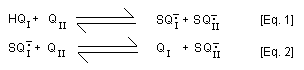
a) Additional H2*(g)* is added to the equilibrium mixture at constant volume.

b) The temperature of the equilibrium mixture is increased at constant volume.

c) The volume of the container is decreased at constant temperature.

d) The graphite pellets are pulverized.

Given: H2(g) + S(s) H2S(g) ΔH = -20.17 kJ



An amount of solid S and an amount of gaseous H2 are placed in an evacuated container at 25°C. At equilibrium, some solid S remains in the container. Answer each of the following questions by stating whether the indicated variable will increase, decrease, or no effect. Justify each answer with a one- or two-sentence explanation.

*(Do not just say the system will shift to the right or to the left. Clearly explain your reasoning.) (2 pts. each)*

a) What will be the effect on the equilibrium partial pressure of H2S gas when additional solid sulfur is introduced into the container?

b) What will be the effect on the equilibrium partial pressure of H2 gas when additional H2S gas is introduced to the container?

c) What will be the effect on equilibrium position when the volume of the container is increased?

d) What will be the effect on the mass of solid sulfur present when the temperature is decreased?

e) What will be the effect on the equilibrium partial pressure of H2S gas when a catalyst is added to the initial sulfur and hydrogen gas that are placed in the container?